THE

JOURNAL OF THE SOCIETY OF ARTS.

VOLUME XXVI.

FROM NOVEMBER 16, 1877, TO NOVEMBER 15, 1878.

LONDON:
PUBLISHED FOR THE SOCIETY BY GEORGE BELL AND SONS,
4, 5, & 6, YORK-STREET, COVENT-GARDEN.

1878.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1305.] FRIDAY, NOVEMBER 23, 1877. [Vol. XXVI.

ONE HUNDRED AND TWENTY-FOURTH SESSION, 1877-78.

Arrangements for the Session.

The following is the Calendar for the Session 1877-78. It is issued subject to any necessary alterations:—

	CANTOR LECTURES.	ADDITIONAL LECTURES.	AFRICAN MEETINGS.	ORDINARY MEETINGS.	CHEMICAL MEETINGS.	INDIAN MEETINGS.
	Mondays.		Tuesdays.	Wednesdays.	Thursdays.	Fridays.
1877.						
November	— — — 26	— — — —	— — — —	— — 21 28 —	— — — —	— — — —
December	3 10 17 —	— — — —	— — — —	5 12 19 — —	— — — —	— — — —
1878.						
January	— 14 21 —	— — — 28	— — — 22	— — 16 23 30	— — — —	— — — —
February	— — 18 25	4 11 — —	— — 19 —	6 13 20 27 —	— 14 — 28	1 — 22 —
March	4 11 18 25	— — — —	— — 19 —	6 13 20 27 —	— 14 — 28	— 15 — 29
April	— 8 15 —	— — — —	— 16 — 30	3 10 — — —	— — — —	— — — —
May	6 13 20 27	— — — —	— 14 — —	1 8 15 22 29	9 — 23 —	3 — 17 —

The Chair will be taken at Eight o'clock at each of the above Meetings.

The Annual General Meeting will be held on June 26th, 1878, at four o'clock.

Ordinary Meetings.

Wednesday Evenings, at Eight o'clock. The following are the arrangements for the Meetings previous to Christmas:—

November 21.—Address by Deputy-Chairman of the Council, W. Hawes, Esq., F.G.S. [In the absence, from ill-health, of Major-Gen. F. C. Cotton, C.S.I., Chairman of the Council.]

November 28.—"The Telephone," by Prof. Graham Bell.

December 5.—"The Weak Points of the Elementary Education Code, with Suggestions for its Revision," by the Rev. E. F. M. MacCarthy. Sir Charles Reed, Chairman of the London School Board, will preside.

December 12.—"Freedom in the Growth and Sale of the Crops of the Farm considered in its bearings upon the Interest of Landowners and Tenant Farmers," by J. B. Lawes, Esq., F.R.S.

December 19.—"The Art of Marbling," by C. W. Woolnough, Esq.

Cantor Lectures.

Monday Evenings, at Eight o'clock. First Course, on "The Manufacture of Paper," Six Lectures by William Arnot, Esq., F.C.S.

Lecture I.—November 26th.—Introductory, Historical, Descriptive, and Statistical.

Lecture II.—December 3rd.—Raw Fibrous Materials; their characteristics and treatment preparatory to pulping.

Lecture III.—December 10th.—Washing, Bleaching, Beating, Loading, Sizing, Colouring.

Lecture IV.—December 17th.—Paper made by hand and by machinery. The Fourdrinier machine. Surface sizing. Drying machinery. Finishing.

Lecture V.—January 14th.—The Chemicals used in the paper mill; their nature, economical use, and methods of valuation. The recovery and re-use of soda as an economical process and in its sanitary bearings. The disposal of washing and machine waters, so as to minimise the pollution of streams.

Lecture VI.—January 21st.—The various classes of Paper; characteristic differences. The determination of the ash or loading. Water supply. General arrangement and construction of the mill.

Second Course, on "The Application of Photography to the Production of Printing Surfaces and Pictures in Pigment," by Thomas Bolas, Esq., F.C.S.

Third Course, on "Some Researches on Putrefactive Changes, and their Results in relation to the Preservation of Animal Substances," by B. W. Richardson, Esq., M.D., F.R.S.

Additional Lectures.

A Course of Three Lectures, on "Explosions in Coal Mines," will be delivered by T. Wills, Esq., F.C.S., on the three following Monday evenings, at eight o'clock, January 28th, February 4th, and February 11th.

Lecture I.—January 28th.—The nature of the Coal Measures. Mining for coal. Ventilation of mines. Composition of coal. Occurrence of fire-damp or marsh gas in mines. Nature and properties of fire-damp. Dangers connected with its presence.

Lecture II.—February 4th.—After-damp or choke-damp. Methods adopted to allow of safe working in fiery mines. Various appliances for lighting mines. The nature of the safety lamp. Different forms of this lamp.

Lecture III.—February 11th.—Connection of the variations of atmospheric pressure with explosions in coal mines. Dangers attending blasting operations in coal mines. Action of coal-dust in certain classes of explosions. The use of the safety lamp as an indicator of the presence of fire-damp, also as a means for its quantitative estimation.

Juvenile Lectures.

A short Course of Two Lectures, suitable for a juvenile audience, will be delivered during the Christmas holidays, by Prof. Barff, M.A., on "Coal and its Components." Special tickets will be issued for these lectures.

Sectional Meetings.

The arrangements for the Meetings of the African, Indian, and Chemical Sections, will be announced in future numbers of the *Journal*. None of the Sections will be opened until after Christmas.

The Society's Proceedings.

THE SESSION.—The Session commences in November and ends in June. The number of Meetings held during the Session amounts to between 70 and 80.

ORDINARY MEETINGS.—At the Wednesday Evening Meetings during the Session, papers on subjects relating to inventions, improvements, discoveries, and other matters connected with the Arts, Manufactures, and Commerce of the country are read and discussed.

INDIAN SECTION.—This Section was established in 1869, for the discussion of subjects connected with our Indian Empire. Six or more Meetings are held during the Session.

AFRICAN SECTION.—This Section was formed in 1874, for the discussion of subjects connected with the Continent of Africa. Six or more Meetings are held during the Session.

CHEMICAL SECTION.—This section was formed in 1874, for the discussion of subjects connected with Practical Chemistry and its application to the Arts and Manufactures. Six or more Meetings are held during the Session.

CANTOR LECTURES.—These Lectures originated in 1863, with a bequest by the late Dr. Cantor. There are Three Courses every Session, and each course consists generally of from Four to Six Lectures.

ADDITIONAL LECTURES.—Special courses of Lectures are occasionally given.

JUVENILE LECTURES.—A short Course of Lectures, suited for a Juvenile audience, is delivered to the Children of Members during the Christmas Holidays.

ADMISSION TO MEETINGS.—Members have the right of attending the above Meetings and Lectures. They require no tickets, but are admitted on signing their names. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor and other Lectures. Books of tickets for the purpose are supplied to the Members, but admission can be obtained on the personal introduction of a Member. For the Juvenile Lectures special tickets will be issued.

JOURNAL OF THE SOCIETY OF ARTS.—The *Journal*, which is sent free to Members, is published weekly, and contains full Reports of all the Society's Proceedings, as well as a variety of information connected with Arts, Manufactures, and Commerce.

LIBRARY AND READING-ROOM.—The Library and Reading-room are open to Members, who are also entitled to borrow books.

CONVERSAZIONI are held, to which the Members are invited, each Member receiving a card for himself and a Lady.

HEALTH AND SEWAGE OF TOWNS.—A Conference is held annually.

MEMBERSHIP.—The Society numbers at present nearly four thousand members. Gentlemen desirous of becoming Members should communicate with the Secretary. Every member whose subscription is not in arrear is entitled:—

To be present at all Evening Meetings of the Society, and to introduce two visitors at such meetings, subject to such special arrangements as the Council may deem necessary to be made from time to time.

To be present and vote at all General Meetings of the Society.

To be present at the Cantor and other Lectures, and to introduce one visitor.

To have personal free admissions to all exhibitions held by the Society at its house in the Adelphi.

To be present at all the Society's *Conversazioni*.

To receive a copy of the Weekly *Journal* published by the Society.

To the use of the Library and Reading-room.

Candidates for Membership are proposed by three Members, one of whom, at least, must sign on personal knowledge; or are nominated by the Council. The Annual Subscription is Two Guineas, payable in advance, and dates from the quarter-day immediately preceding election; or a sum of Twenty Guineas in lieu of all further contributions, may be paid.

All subscriptions should be paid to the Secretary, and all Cheques or Post-office Orders should be crossed "Coutts and Company," and forwarded to him at the Society's House, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

FIRST ORDINARY MEETING.

Wednesday, November 21st, 1877, William Hawes, F.G.S., Deputy Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society :—

Allen, Samuel, Canal-road, Mile-end. E.
Andrews, William Ward, 238, Kingsland-road, E.
Aumonier, F., 110, High-street, Manchester-square, W.
Bache, Alfred, 10, Victoria-chambers, Victoria-street, S.W.
Barker, John, 252, Cornwall-road, Notting-hill, W.
Barratt, Samuel, 55, Wood-street, E.C.
Bayliss, John, 5, Victoria-street, Westminster, S.W., and Surbiton, Surrey.
Bishop, William, 174 and 176, St. John-street, E.C.
Bosanquet, William David, St. Stephen's Club, Westminster, S.W.
Boyd, John Frederick, 68, Upper Thames-street, E.C.
Broadberry, William Henry H., The Gas Works, Tottenham.
Buckler, John Russell, The Lower Gannicox, Stroud, Gloucestershire,
Carlisle, Henry, The Eastern Telegraph Company, Bombay.
Carpenter, H. S., F.C.S., Palace Chambers, St. Stephens, Westminster, S.W., and The Firs, near Alton, Hants.
Conrad, Julius, 13, Pembridge-gardens, W.
Curtis, C. H. O., 3, Crawshay-road, North Brixton, S.W.
Dangerfield, William, 59, Bartholomew-road, N.W.
Davidson, Alexander, M.A., Addison-lodge, Ridgway, Wimbledon.
De Carvalho, Joseph Brant, C.E., care of F. Youle, 155, Fenchurch-street, E.C.
De Cornelissen, Louis, 22, Great Queen-street, W.C.
Dick, G. Alexander, 110, Cannon-street, E.C.
Drew, Joseph, M.B., 4, Foxgrove-road, Beckenham, Kent.
Duckham, Heber, Millwall, E.
Dutch, Louis L., M.A., 97, Lower Mount-street, Dublin.
Fenwick, Mrs. Elizabeth H., Chapel Allerton, near Leeds.
Field, Walter, The Pryors, Hampstead, N.W.
Finn, Alexander, British Embassy, Teheran.
Forsyth, Sir Thomas Douglas, 76, Onslow-square, S.W.
Gainsford, Thomas Robert, Whiteley-wood-hall, near Sheffield.
Gandon, Charles, Crystal Palace District Gas Company, Lower Sydenham.
Glendinning, Andrew, 76, Chancery-lane, W.C.
Goffin, Robert Edwin H., F.C.S., Alexandra-street, Victoria-street, Westminster, S.W.
Gough, Ralph D., Willenhall, near Wolverhampton.
Guest, Sir Ivor Bertie, Bart., Muckross Abbey, Killarney.
Hall, Charles Edward, 22, Grove-terrace, Leeds.
Harper, Thomas Henry, the Phœnix Work, near Redditch.
Harris, Henry, M.D., Trengmeath, Redruth, Cornwall.
Herington, William Henry, 1, Halbrake-terrace, Wandsworth, S.W.
Horn, T. S., 60, Hawkesley-road, Stoke Newington, N.
Houghton, Francis Evelyn, C.E., Crossness, Erith, Kent.
Hudson, William, 43, Moorgate-street, E.C.
Key, John Thomas, Bromsgrove.
Knight, James, Portway-house, Weston, Bath.
Knowles, Thomas Foster, 48, Moorgate-street, E.C.
Le Maitre, Charles Edward, 8, Ramle-terrace, Egremont, Cheshire.
Leslie, Joseph Blockburn, Sheffield.
Lindley, William, Frankfort-on-Maine.
Martin, John Henry, York-chambers, Adelphi, W.C.
Martin, W. H., 11, Markham-square, King's-road, S.W.
Maude, Frederick, Royal Mews, Buckingham Palace, S.W.
Meredith, Alfred John Rouse, Durham-villa, Wandsworth-common, S.W.
O'Donoghue, William Power, Mus. Doc., 11, Peter-place, Adelaide-road, Dublin.
Ormiston, Thomas, C.E., Ormidale, West Dulwich, S.E.
Osler, A. Follett, South Bank, Edgbaston, Birmingham.
Pare, Cornelius Benjamin, 30, Finsbury-square, E.C.
Patterson, John, 9, Inverness-terrace, Kensington-gardens, W.
Peak, Henry, 3, Market-street, Guildford.
Perkins, Loftus, Seaford-street, Regent-square, W.C.
Phillips, William, The Lancrets, Luton, Bedfordshire.
Proctor, Richard Anthony, 2, North-road, Clapham-park, S.W.
Reynolds, Alfred, 112, Jamaica-road, Bermondsey, S.E.
Robinson, S. H., Calcutta.
Sanders, John, Belmont, Selhurst-road, South Norwood, S.E.
Smith, Frederick Charles, M.D., 21, Gower-street, Bedford-square, W.C.
Thomas, Charles, 2, Great St. Helen's, E.C., and Clarendon-house, Buckhurst-hill, E.
Thornely, Edward, West Brow, Arkwright-road, Hampstead, N.W.
Thornely, William, Reform Club, S.W., and West Brow, Arkwright-road, Hampstead, N.W.
Vyse, Griffin William, F.R.G.S, F.G.S., &c., Mooltan, India.
Walker, Major-General George Warren, R.E., 1, Marlborough-buildings, Bath.
Walker, James Alexander, C.E., 14, Queen Victoria-street, E.C.
Wallis, Charles James, 11, Montpelier-row, Blackheath, S.E.
Warren, John V., 4, Beresford-place, Dublin.
Willson, Alfred Rivers, Ph.D., 368, Clapham-road, S.W.
Wright, Miss Christian E. Guthrie, 6, Lynedoch-place, Edinburgh.
Wrigley, William Sanders, 71, Tredegar-road, Bow, E.

Corresponding Member.

Orovia, His Excellency Don Manuel, Marquis de, Minister of Finance of Spain, Madrid.

The Chairman delivered the following

ADDRESS.

Before I commence the address it is now my duty to deliver, allow me to explain the cause of my occupying the chair on this occasion.

You are aware, at least the members of the Society present know, that General Cotton was elected to be its Chairman for the coming year. Unfortunately, however, he was suddenly obliged, from severe illness, to tender his resignation, but the Council, rather than accept the resignation of so distinguished a member of the Society, requested me to act for him, until the improved state of his health may enable him to undertake the duties of the office.

It was in the year 1863 that I first had the honour to preside over the Council of the Society, and, by the favour of my colleagues, I filled the office of Chairman for four years. I can now, after a lapse of 14 years, during which time I have constantly attended the meetings of the Council, review the interesting and important work

it has accomplished during that period, and point out, I hope, the direction in which it may continue its career of usefulness, and obtain still increased credit for its labours as one of the oldest, most practical, and most cosmopolitan in its operations amongst the numerous societies in this country.

Before, however, proceeding to the general business of the evening, let me devote a few words to the memories of the most distinguished of our members whom death has taken from us during the past year.

Sir Titus Salt, Bart., was one of these. He was a man of powerful mind and of great energy of character, but the very interesting obituary which will be found in a January number of our *Journal*, renders it unnecessary for me to do more than ask you to allow me to draw your attention for a few moments to the intelligence and perseverance he exhibited in establishing and conducting the large manufacturing works at Saltaire, over which he for many years presided; to the liberality with which he provided his workmen—between 4,000 and 5,000 in number—with above 800 good and wholesome dwellings; to the opportunity he afforded them for the acquirement of practical and useful knowledge, by the establishment of lectures, libraries, and reading-rooms; to the churches and chapels he built for their religious instruction; to his attention to their health by establishing a dispensary, baths and wash-houses, and other sanitary appliances; to the schools he built for the education of their children; and to the park he provided for the recreation of both old and young, thereby proving himself to be a man of large, enlightened, and catholic mind—for his liberality was not confined to his own workmen and district—desirous of promoting the welfare of all connected with him. He was an active promoter of the Exhibition of 1851, and of the National Training School for Music. Such a man ought not to pass away without an acknowledgment by the Society of the great services he rendered to the district in which he lived and to mankind.

Admiral Sir Edward Belcher, K.C.B., was an old, well-known, and esteemed member of the Society, which he joined soon after his retirement from active service. He entered the Navy in 1812, served in the West Indies, and was at Algiers, where he was wounded. He then went on a surveying voyage under Captain Beechy, and afterwards from 1852 to 1854 was appointed to the command of a similar voyage to the Pacific. He also commanded the expedition sent in search of Franklin.

Benjamin Shaw was a very useful member of the Society. He took great interest in the proceedings of the Food Committee, and having given £50 for a special course of lectures on Industrial Hygiene—he founded a prize in connection with this subject of £20—to be given every fifth year.

By the death of Major-General Eardley-Wilmot, R.A., F.R.S., the Society has lost a member who, after serving on the Council for several years, was elected Chairman in 1871, which office he held for two years. His health, however, soon failed, and the Council has recently, by his death, lost the advice and counsel of a distinguished officer in her Majesty's service, and of a high-minded gentleman, whilst the Society has lost a member whose courtesy to every one gained him universal respect and esteem.

One other name I must mention, Sir Matthew Digby Wyatt. He took a very active and distinguished part in the management of the Fine Arts Department, in the Exhibition of 1851, and published a volume, beautifully illustrated, with artistic and very accurate descriptions of the most choice specimens of china-glass and ancient and modern *repoussé* work. He became the architect to the East India Company, which office he retained until his health gave way, when he left London and resided in Wales, where he died in October last.

Passing, then, from this part of my subject, gratifying as it is to look back and mark how many distinguished men have been members of the Society, and have contributed to its general prosperity by the special information they possessed in the various branches of science to which they had directed their attention, we must now try to benefit by the examples they have afforded us, of what a member of Council can do to promote the objects for which the Society was established.

There are wide fields of inquiry open to us. The Society has hitherto maintained its position, because no subjects relating to Arts, Manufactures, and Commerce have been too small or too large to receive its attention. If a subject is small, or apparently unimportant, but has a character of novelty and of practical utility, we give it the benefit of our approval and reward—from a simple, cheap, and compact writing-case, suited to the wants of our travelling millions, to large and extended inquiries into the products of foreign countries, the Council is always ready to devote its attention to the one as to the other. Whether to enlarge our supply of food, or in the search for raw materials, vegetable or mineral, to supply the demands of our manufacturers, to one and all the accumulated information of the Society is always at the service of members and of their friends.

But besides this attention to material interests, a large portion of the time of the Council has been occupied for several years past in the study of the laws of hygiene, and their application to the supply of water, to ventilation, to drainage, to general cleanliness, to domestic economy, thereby assisting in the improvement of the health and consequent longevity of the people, so as to remove from us, as a nation, the opprobrium of allowing thousands of our population to die annually of preventible diseases, which exist, and are disseminated for want of proper attention to principles which all now admit to be essential to the health and well-being of the population, at present unavoidably crowded together in our great cities in unwholesome habitations. I cannot to-night do more than give a brief sketch of the proceedings of the committees, appointed to consider the improvements which have already been introduced into the management of these great national questions, and the progress which is being made in the introduction of sanitary appliances.

To supply a sufficient quantity of water for the protection of life and of the buildings and property of this great city from fire, which, large and full

of wealth as it is, seems to be ever increasing, is of the utmost importance; but to secure a supply of water of sufficient purity to ensure, as far as human skill can do, the immunity of its millions of inhabitants from preventible sickness and disease, is even of greater importance. Apart from the suffering entailed upon individuals by the loss of time and cessation from useful labour, it represents in the aggregate a large loss of wealth to the nation. To obtain a sufficient quantity of good water, and then to distribute it so as to meet the wants of the general public for household and drinking purposes, for the extinction of fires, and for our manufacturers, is now occupying the attention of engineers and philanthropists; but I fear success in the accomplishment of the vast works required fully to remedy acknowledged evils, and to overcome the opposition of existing interests, will only be attained when the country, by some great mortality, is made sensible of the disgrace of allowing the continuance of the present insufficient and dangerous system, and resolves that the preservation of the public health is a matter of first necessity and of national economy, and demands that a national effort shall be made to secure, not only for the metropolis, but for every city and town, the inestimable boon of an ample supply of pure water.

But, whilst admitting the necessity of improvement in the supply of water for all purposes, do not let us be led too easily into a lavish and extravagant expenditure, and at the same time to the destruction and waste of a large amount of property now very profitably employed in the collection and distribution of water.

It appears to me to be better to direct our attention to the improvement of our present supply, by collecting it from better sources, than to promote the establishment of a separate supply of potable water.

Many improvements may be introduced, I have no doubt, in the arrangements, for the night service to be available at a moment's notice in case of fire. Much, however, has been already done in this direction by the water companies, and by the activity of the Fire Brigade; and, for the removal of the still existing grounds of complaint, we must, I think, look more to wholesome pressure being put upon the water companies, than to the establishment of a new system. I shall be very sorry to see, as some advocate, the transference of the management of our water supply, either to the Government or to the Board of Works. Indifference towards the progress, management, and principles involved in the administration of our public works, is growing too rapidly to allow another great branch of municipal administration to be withdrawn from independent control, and placed under official direction, without a protest from a Society which has always been distinguished by its advocacy of the greatest freedom of action, in all matters relating to the social and industrial progress of the people.

We are often told to look to the success of the main drainage and of the Embankment, both executed under the direction of the Board of Works; and Liverpool and Manchester are both referred to as evidence of the advantages to be derived from placing the supply of water under the management of their respective corporations; but the same grounds for anticipating advantageous results do not exist here. Two or three of our companies are each of them supplying a larger quantity of water than is supplied by the corporation works in those towns. Were the purely administrative expenses of all the London companies saved, the resulting economy to each house would be trifling; therefore, I think the question must be considered first, rather with a view to improve than to destroy our existing establishments. Nevertheless, the knowledge we possess of the gradual lowering of the level of the water in the chalk would lead us to ascertain by experiment what quantity of water would be supplied by one of the many wells proposed to be sunk, and also what might be the effect of a period of drought on such supply. This is one of those subjects upon which a great deal may be said, and very popularly said, without a due appreciation of the difficulties to be overcome, and the alterations and expenses they must entail upon property in every city and town where proper water-works and a double service system are introduced, to the displacement of the established means of supply. Practically, to secure a supply of pure drinking water involves a separate system of supply and delivery. The water must be brought from special sources. The expense, except in the size of the mains, will be the same as for ordinary water-works. There must be distinct house services, and unless this is made compulsory, it would, I fear, be a long time before householders would adopt such a double system, for it would be difficult to convince them of the advantages to be derived from it.

It is singular, when so much attention is being paid to the subject of water supply and drainage, to discover how little care has been exhibited in the construction of our most important residences, and if this be so, may we not ask with alarm and surprise what is the condition of the streets and of the houses inhabited by the great mass of our population.

Surely great blame must rest somewhere, when, even with such knowledge as we have, it is now discovered that the residence of the Heir Apparent is evidently undrained and unventilated, and has been built over a nest of old drains and cesspools, the gases arising from which must permeate the buildings above, and render them unfit for habitation.

We are fortunate, however, in having one member of Council (Mr. Edwin Chadwick) who has devoted so much time to inquiries on these subjects, that no better guarantee than his presence can be required to ensure that they will not be neglected in future.

Besides the time and attention devoted to inquiries on questions affecting the health and well-being of the people, the Society has continued its educational work, and must view with the greatest interest and satisfaction the result of its examinations, and the adoption by the Department of Science and Art, the Universities of Oxford and Cambridge, and other public bodies, of many parts of the system first introduced by the Society, and which for so many years has been conducted by it under considerable difficulties.

The success which has attended the educational

work of the Society affords a striking example of the advantages to be derived from the existence of an institution like ours, which can afford to pursue an independent, and for a time even an unpopular course, relying on the gradual adoption of its views by the public.

The establishment of these examinations in 1856, in connection with mechanics' institutions and other educational societies in all parts of the country, has worked most beneficially; a considerable number of subjects are still retained in the examination programme, and members of the institutions in union with the Society, and others in various parts of the country, still avail themselves of the advantages they offer.

The encouragement of technological instruction was commenced by the Society in 1873. The progress hitherto made has been slow, but there is every reason to believe that the attention which is now given to it will soon be appreciated.

A proposition, in the realisation of which this Society must feel great interest, has emanated from a few of the great City companies, to establish in the City a college for instruction in technical science, applied and theoretical. The idea is a grand one, and the plan shows great liberality on the part of the companies with whom it has originated, but it will require, I fear, considerable time for its realisation. It may, indeed, be prudent to begin on a less imposing scale by trying, in the first instance, to establish a central trade school, where managers and foremen might receive technical and scientific instruction as applied to their respective industries.

The first practical step taken by the Committee representing the City Companies, has been to obtain suggestions as to the best means of founding the proposed technical college, and, among others, our own Assistant-Secretary, Mr. Wood, has contributed a valuable paper, some portions of which I have had an opportunity of looking over.

Looking, then, to the educational work which has been done in the last 15 years, and to the greater facilities which are now afforded for the education of all classes, especially of the upper and intelligent working class, no one can doubt that the mental action of these School Board scholars, who will soon be our workmen and artisans, is being most beneficially stimulated. The middle-class boy will often enter life in competition with the son, perhaps, of his father's workman, and if he does not use the superior advantages of his position as he ought to do, he will surely be out-run in the race of life, and be made to feel when too late the value of the opportunity he has lost.

Domestic Economy is a comparatively new subject. It appears, however, likely to excite considerable interest, and I think those who have read the papers submitted to the Congress held in October last at Birmingham, and also the discussions which took place upon them, will not fail to acknowledge that a new educational field is opened, likely to produce most beneficial results, and will, I hope, be the means of largely increasing the number of candidates for examination. The Congress was so successful, that another will be held next year at Manchester.

Two branches of instruction recently added to our programme have been thoroughly appreciated by the public. The "drill" for children of all classes must, when 10,000 children can be brought together to show their progress, be considered as having become a national institution. Here, again, the work begun on a small scale by the Society, has expanded rapidly and successfully.

The drilling of boys in industrial, national, and other schools has given them a more manly and independent appearance—it is calculated to encourage their growth, and to make them feel an interest in our new national force of volunteers, of which they may become efficient members, and thereby better and more useful citizens in their different spheres of life.

The other branch of education—music—only recently restored to our list, and in the progress of which the Society takes great interest, is producing beneficial national results.

Until the last few years, music as a branch of popular education has been unknown. We were almost dependent upon foreigners for musical talent. Now, thanks to the exertions of members of this Society, a National Training School for Music is established, and as instruction in instrumental music forms part of the drill system, each school having its band, music is now being taught in its highest as well as in its more popular form, with the best results upon all classes, and this will, I believe, in a short time produce a good effect on the national character. Fifty years ago, singing at public dinners was almost confined to Bacchanalian songs, mixed with the popular nautical and national songs of Dibdin and Burns. Now, it is an important part of the entertainment, and the almost universal study and appreciation of music is elevating the tone of our public gatherings, whether for pleasure or for charitable and other purposes; another has been specially promoted by the admission of ladies, who, a few years ago, were almost excluded from them, or if admitted, were accommodated in some special gallery or behind a screen. I may also refer in evidence of the steadily increasing taste for music, not only secular but sacred, to the improvement which has been introduced in the music of our churches.

The Patent-laws still excite great interest among the members of the Society. My opinion in opposition to these laws has often been expressed in this room. Valuable papers have been read, and interesting discussions have taken place upon them, but I have not observed that some of the most important arguments against these laws have been duly considered. They are supported generally on the ground of the protection they afford to inventors. To this, if accomplished, no one would object, but the difficulty is to determine who is an inventor, and what is an invention deserving the protection of a monopoly in its production for 14 years, and consequently, if the patent system were perfect, an enhanced price to the consumer.

Then the Patent-law virtually imposes upon the inventor the publication of the most accurate drawings and specifications of his invention, which, at the time when the Patent-laws were first enacted in 1624, was not necessary either in the interest of the public as in that of the inventor. But

now the drawings, originally intended for reference, and as evidence of the exact nature of the invention, are published by the Patent-office, and circulated in all foreign countries, placing every foreign mechanist—who is at liberty to make what use of them he can—in a better position than our native workman, and at the same time seriously injuring the English patentee; in fact, destroying that protection and monopoly he expected from his patent.

One of the greatest difficulties in connection with the Patent-law is the determination of what is a new invention. It can hardly be maintained that a modification or improvement in the arrangement of parts of a new machine can entitle the improver to a monopoly of the same duration as that given to the original inventor.

An original inventor, or the discoverer of a new process beneficial to the country at large, deserves reward. But, except in very exceptional cases, does the Patent-law secure to him this reward?

It would be better that a reward, however large, should be given by the State, when the novelty and public utility of an invention had been proved, than that thousands of useless patents should be granted, by which progress in invention is retarded, and difficulties and impediments placed in the way of a real genius, who, after years of labour, perfects that which he has long striven for, and then finds that he cannot proceed without first meeting demands made upon him for claims for rights obtained under scheming and useless patents, taken out mainly for speculative purposes.

The number of useless patents taken out is shown by the returns of the Patent-office, which show that in the last completed return, out of 2,497 patents sealed, only 793 were kept in force for seven years, and only 309 after the first seven, for the full term of fourteen years.

Next to the Patent-laws, the subject most interesting to the members of our Society is that of the existing relations between masters and workmen—between capital and labour, as influenced by the action of trades' unions or otherwise. During the past year, a large number of communications have appeared in the public press on these subjects. I think we may congratulate ourselves that the spirit actuating the leaders of trades' unions is more reasonable and more intelligent than it was a few years since; not that the principles which guide their action are more liberal, or show a better knowledge of political economy in its relation to the production of manufactures than they have previously done, but that there is greater liberality and consideration for, and toleration of, the opinions of others displayed in their discussions, and a greater desire to meet and consider their grievances, and the best mode of alleviating them, than formerly. There is greater willingness to refer their disputes to able and disinterested men; and perhaps the greatest cause of anxiety at the present moment respecting their action and their influence upon the future of, the manufacturing industry of the country, is to be found in the spirit of protection—of opposition to free trade—which is evidently making progress among their leaders, and which appears unfortunately to be reviving among a few of the more educated classes, calculated to do great injury, and which cannot fail to be most injurious to the manufacturing industry of the country.

This appears to me to be the necessary outcome of the restrictions working men are arbitrarily imposing on the hours of labour and upon the uniformity of the rate of wages to be paid for it, irrespective of the quantity or quality of the work done, and which they are endeavouring to enforce, both being based on the limitation of the supply of labour to benefit a minority at the expense of the majority, and upon the idea that Englishmen have reason to fear foreign competition.

On this subject I may safely quote the opinions formed by the artisans selected to go to the Paris Exhibition, to be found in a paper I read before the Society in 1867, in which I state that "the men were selected with reference only to their fitness for the duty they undertook, and this was judged of by the recommendations they brought, either from their employers or fellow-workmen, and it is remarkable that men so chosen, some belonging to the most powerful trades' unions, others taking an active part in political associations, and others priding themselves on their independence of any union or political association, should most of them breathe the same spirit in regard to the superior position of labour in this country as compared with that in France and foreign countries generally. There is no despondency on the minds of these men. They do not fear competition on fair and equal terms, or doubt the activity of the inventive genius of their country." They admit inferiority in certain branches of handicraft, but nearly all attribute this to the want of the opportunities foreigners enjoy of studying as youths and adults works of ancient and modern art.

Not one of the 80 who went to Paris advocate uniformity of wages—most approved piece-work—most admitted that the English workmen had to compete with cheaper labour, and nearly all agreed that the mere price paid was not the sole ground of comparison of the value of labour, which was to be found in a proper estimate being made of the quantity and quality of the work done.

Considerable interest was excited among working men when these reports were published, and I hope a reference to them will not be misplaced now, when many of our English workmen appear to be doing all they can to neutralise the advantages they enjoy, and to place the slow and unskilful workman on a par with the most industrious and most skilful.

I hope our Society will continue in the course it has so long pursued, of advocating in its fullest sense the right of every man to bring his labour and the produce of his labour to the best market, and that, whilst admitting the right of union among all classes for any purpose calculated to improve their position in life, it will point out that the limit of the beneficial action of unions is easily passed, and that, where the regulations for their government, and the rules they enforce on their members, restrict or increase the cost of production, they will become the stimulators of foreign competition and the enemies of their own interests. They will foster, not a wholesome competition which ought

always to exist, and which benefits all countries alike, arising as it mostly does out of natural advantages of climate and soil, but one which, increasing the cost of home productions, gives the foreign manufacturer a margin of cost to enable him to teach his workmen, not subject to similar restrictions, to equal if not excel our own.

The trades unionist endeavouring to restrict production, by limiting the number of apprentices and the hours of labour, forgets that whilst doing this, he stimulates the instruction of apprentices and rivals abroad, both as workmen and masters, whose competition they do not now see but will soon seriously feel, and which is silently undermining their prosperity.

Other important subjects have occupied the attention of committees of the Society, among which the most important have been drainage and sewage. It has been their object to collect, from all sources at home and abroad, and to disseminate, the best attainable information relating to the collection and economical distribution of sewage. I fear, however, notwithstanding the attention which has so long been devoted to the subject, but little has yet been accomplished.

In large cities and towns the sewage is mainly removed by drainage works, but in small towns and villages this is not easily accomplished, and the difficulty is increasing day by day, as the preservation of the purity of the water in our rivers, and in the rivulets supplying them, is attended to.

The prevention of the pollution of our rivers, which has already attracted the attention of Parliament, and the consequent preservation of fish, has already produced most beneficial results; but, until some plan for adequate house drainage and the removal of the sewage is devised, and its application made compulsory, our small towns and villages will continue to suffer, as they now do, from the injurious effects of inadequate sewerage and drainage, and the consequent perpetuation of fevers and other preventible ailments.

A conference on the Health and Sewage of Towns was held here in May last, the Right Honble. James Stansfeld, M.P., presiding. The proceedings were published in the *Journal*, and have excited considerable correspondence therein.

For several years the Food Committee has been collecting information as to the best mode of obtaining meat from foreign countries or from our Colonies. The numerous chemical and practical questions arising as the committee proceeded in its inquiries, necessarily occupied a long period of time to determine. Each experiment required months, we may almost say years, to test its success or failure. All the Society could do was to collect and disseminate information, to offer prizes for successful experiments, and to afford to all interested free access to the results obtained.

The Society is now able to report that arrangements are made, and have been carried, to a great extent, into successful operation, for the importation of dead meat from Canada and the United States, as well as preserved meats for our colonies. In October, 1875, only 36,000 lbs. of dead meat were imported, which increased, in April, 1877, to above 8,000,000 lbs. from Canada, New York, and Philadelphia, exclusive of live stock from Canada. This food can only be obtained in exchange for the products and manufactures of this country, and any obstacle to their production, or unnecessary increase of their cost, by combinations of any kind, whether of masters or workmen, lessens our power to buy, and assists in the maintenance of that high price of meat which all classes, rich and poor, have for many years past felt so severely.

The impolicy of imposing restrictions, or regulations of any kind, on the freest employment of labour, cannot be more clearly exhibited than in their effect upon the foreign supply of food, or too constantly impressed on the popular mind.

Every restriction upon labour, or interference with the most perfect freedom in its employment, with a view to enhance its price, only lessens the power of a merchant to exchange the products of labour for food. The workman apparently obtains more money, but he requires more for the maintenance of his family, and it is the working man who first most severely feels a high price of food.

The Indian Section recently established has been most successful. It has been supported by the most able authorities on the commerce and productions of the three Presidencies, and bids fair to accomplish most useful results.

The committees on Indian affairs have been well attended, and their proceedings have attracted much attention.

The progress of railways and their future extension and development were most ably treated by Mr. Danvers, and his paper was published separately.

Papers upon the increasing growth of tea, and the probability of our obtaining a new source of supply of wheat from India, were most interesting, and elicited in their discussion most valuable information.

The African Section, also recently established, has excited unusual interest, as there is no part of the globe which, at the present moment, more thoroughly enlists the sympathy of England than the Continent of Africa.

I had the pleasure of reading a paper on "The Products and Resources of South Africa," in 1859, pointing out the opening that existed in the colony for English enterprise and emigration, and it is most gratifying to see the great extension of trade and population, and of the general resources of the colony which have taken place in little less than 20 years.

Diamonds were then unknown. The colony was only then beginning to recover from the unfortunate colonial policy of Lord Glenelg, who in 1836, instead of protecting the colonists, justified the invasion of the Eastern Province by the Kafirs. This policy was not maintained under Lord Stanley's colonial administration, from which time the prosperity of the colony has uninterruptedly continued. In the last 10 years diamonds of the value of £15,000,000, have been exported, three specimens of which Mr. Tennant has kindly placed on the table for the in-spection of members.

The interest, however, in these valuable stones, does not depend alone on their having been found in one of our colonies, or on their beauty and intrinsic value, but upon another fact, that they have been cut by English workmen, who, from the increased experience obtained in cutting the large number of stones found at the Cape, are now recovering the art of diamond-cutting, which for a long

time past had been lost in this country, and monopolised in Amsterdam. But, however great may have been the progress hitherto of the Cape colonies, what a marvellous future is now before the whole Continent of Africa, since the knowledge of its great mineral wealth, and its vegetable resources, has been recently made known to the world by Lieut. Cameron and Mr. Stanley.

Our generation has seen the abolition of slavery in the West Indies and America, of serfdom in Russia, and now, thanks to the indomitable courage and perseverance of these indefatigable travellers, we may hope, ere long, to see it abolished in Africa.

Many valuable lives have been lost in the attempt to accomplish that which is now achieved, but much as this must be regretted, the millions of lives which will be saved in the next few years, when slavery is abolished in Central Africa, must be admitted as amply justifying the sacrifices we have made.

Having thus directed your attention to the various subjects which have occupied the time of the Council during the past year, I hope you will allow me to sketch, and it can be only to sketch, the probable direction of its business for the year before us.

Perhaps one of its most important duties will be the collection of facts at home and abroad, to show the folly of the revival of the demand for the imposition of protective duties on foreign manufactures and productions, under the specious plea of reciprocity, in illustration of which, I can only just refer to the effect recently produced in America by the imposition of high protective duties.

If we are the cheapest and best manufacturers in the world—which is conclusively shown by the extent of our foreign trade—foreigners will buy of us, and if they can in return supply us with cheap food, let us buy of them.

They may impose duties either for revenue or for the so-called protection of their trade, but of what avail is that protection if they cannot find customers for their goods, which they will not do if by these prohibitive duties on imports they stop the current of exchange on which the life of commerce depends.

The fear is, rather, at the present time, that the mischievous operation of trades unions will put a higher protective charge on our manufactures, by the increased price of labour, than any protective duty foreign countries are likely to levy, or the advocates of reciprocity would impose here.

A new institution, which will ultimately, I hope, be useful to the working classes, is being worked by one of our members—"The National Penny Bank." We all know the influence of the penny, whether invested in a halfpenny or penny postage stamp, in newspapers, in street toys, or in penny steam-boats. It is the multitude of pennies that secures the success of each of these branches of our great total of business, and builds up the £5,000,000 of postal revenue, the millions received from penny newspapers, and which, if contributed by the penny thrift of the millions of the industrial classes, would build up a banking balance large enough to make a bank pay. But it will require care, economy, and good management, with time —the great element of success in all industrial occupations—to make it succeed.

On former occasions I have generally noticed the progress of the fine arts and of public improvements.

There is little, I must regret, to which I can specially direct your attention. I fear that painting has not yet overcome the deadening effect of the wonderful advance in photography, whereby the most beautiful compositions are reproduced with accuracy and effect, so as to supply the public want of beautiful subjects to adorn their walls or portfolios.

In architecture we may congratulate ourselves upon an improved taste in the designs for our public buildings, and if we carry our minds back twenty or thirty years, all must be struck with the improvement which has taken place, and which, if continued at the same rate for a few years, will render this metropolis the most beautiful city in the world.

It is impossible for me to do more than just to refer to the advance which has been recently made in the science of electric telegraphy, but I must not omit a slight notice of the most recent applications of the electric current to the audible reproduction of the human voice, which appears to surpass all other modern discoveries, great as they have been.

It is so novel, so wonderful, and appears likely to be of such great importance, that I can hardly venture to describe that which, at present, I scarcely understand.

There is but little doubt that the telephone is the most startling scientific novelty of the present time, and the Council are glad to be able to announce that they have succeeded in inducing Prof. Bell, the inventor, to read a paper to you on the first possible opportunity—the first meeting of the Session for the reading and discussion of papers. That human speech should be transmitted over leagues of space by the electrical current has been long a dream of electricians; but, until the discoveries of Prof. Bell, it was nothing more. Now, by the marvellously simple apparatus which that ingenious inventor has devised, it is not only possible, but easy, for a person to hold a conversation with another, at a distance of many miles, with no greater difficulty than if the two were talking through a speaking-tube from this floor to the floor below. Certain technical difficulties yet intervene before the telephone can be used for the post-office or railway lines, for such is the wonderful delicacy of the instrument that it is affected not only by the currents in its own wires, but by those in any wires adjacent, and these must be not only insulated but isolated and apart from all others before the telephone can be used on crowded lines. For other purposes, even in its present form, the instrument is perfectly available, and there can be but little doubt the invention has a great future before it. Perhaps even more remarkable to thoughtful minds are the great possibilities that this, like every discovery in an absolutely new field of science, opens up. There can be little doubt that in the hands of the many skilful physicists who are now at work on the subject, the instrument will be greatly developed, and perhaps those are the wisest who regard it, not as a perfected invention, but as the first suggestion of much that is to come from a fresh application of science to the purposes of daily

life, the great aim and object of the Society of Arts.

There is also another application of electricity to practical uses which is just now receiving special attention, and that is the production of light thereby. This source of light is gradually coming into use in Paris, where several large industrial establishments have adopted it with success. You are aware that the voltaic arc gives us, when it is produced by means of the magneto-electric machines, by far the cheapest available source of artificial light. If we burn coal in the furnace of a steam-engine, and set that engine to drive a Gramme, or a Siemens, or a Holmes machine, we can obtain a very much greater amount of light than if we burn the same amount of coal in a gas-retort and burn the gas therefrom. The gas, however, we can take where we please, and we can burn it part in one place and part in another. The light from our electric lamp is concentrated at a single spot. It was to overcome this objection that Mr. Jablochkoff derived his very elegant and ingenious "electric candle," and he so far succeeded, that he can, as it were, split up the one strong light into three, or four, or five smaller lights, all within a certain limited distance of one another. Beyond this I do not think that he has gone, or, without such fresh development of electrical science, that he will go. Still the apparatus is most ingenious, and I am not without hope that some future evening may be devoted to the discussion of this and the other known methods of electric lighting.

Besides the other business of the Session, the Cantor Lectures will be given as usual, and two juvenile lectures will be given, particularly for the children of members. The first course of these lectures was so popular last year, that no time must be lost by those who wish to attend them in applying for tickets.

Before I conclude, I must say a few words upon the American Exhibition.

It was most popular in Philadelphia. The number of persons paying for admission was above 8,000,000, which exceeded the number admitted to any former Exhibition, except in Paris in 1867, when 9,300,000 were admitted. The space allotted to English exhibitors was very large, but I fear, as a whole, this country was not very strongly represented.

The high duties to be paid on the importation of foreign manufactures lessened the number of exhibitors, and deprived the Exhibition of the great charm of all those that preceded it, that of being a universal exhibition of all nations.

I have now only to refer briefly to the very satisfactory position of the Society at this moment.

Our members continue to increase, our finances are in good order, our officers are zealous in their work, and the general objects of the Society, the promotion of Arts, Manufactures, and Commerce, are being steadily, and I believe, beneficially carried out.

After the conclusion of the address,

Lord Alfred Churchill moved a vote of thanks to Mr. Hawes, which was seconded by Mr. Botly, and carried unanimously.

The Chairman then presented the following medals and prizes:—

The Society's Gold Medal to Mr. Pintsch, for an improved system of lighting railway carriages.

The Society's Silver Medal:—

To Professor Barff, M.A., for his paper on "The Treatment of Iron for the Prevention of Corrosion."

To J. Meyerstein, for his paper on "Stenochromy," a novel method of printing in colours.

To A. J. Ellis, F.R.S., for his paper on "The Measurement and Settlement of Musical Pitch."

To B. St. John Ackers, for his paper entitled "Deaf, not Dumb."

To Commander Cameron, R.N., C.B., for his paper on "The Trade of Central Africa, present and future."

To James Irvine, for his paper on "Our Commercial Relations with West Africa, and their Effects on Civilisation."

To Sir Douglas Forsyth, C.B., K.C.S.I., for his paper on "The Progress of Trade in Central Asia."

To W. Thomson, for his paper on "The Sizing of Cotton Goods."

The Prince Consort's Prize of Twenty-five Guineas, accompanied by a special certificate, to Alfred Carter, aged 25, of the Birkbeck Literary and Scientific Institution, clerk in Civil Service, who, at the Society's late Examinations, passed in the First-class in the following subjects during the specified period:—

1874. English History.
1875. Commercial Geography and History.
,, Arithmetic.
,, Political Economy, with the First Prize of £5.
1876. Book-keeping.
,, English.
1877. Clothing, with the Second Prize of £3.
,, Housekeeping and Thrift, with the Second Prize of £3.
,, Cookery.

The Council Prize (for Female Candidates) of Ten Guineas, accompanied by a special certificate, to Mary Susan Mungeam, aged 34, of the Birkbeck Literary and Scientific Institution, who, at the Society's late Examinations, passed in the First-class in the following subjects during the specified period:—

1875. Commercial Geography and History.
1876. English.
1877. Housekeeping and Thrift, with the First Prize of £5.
1877. Cookery, with the First Prize of £5.

JUVENILE INDUSTRIAL EXHIBITION AT BALLARAT.

The following communication has been received by the Secretary from Mr. Norman MacLeod, the Assistant-Secretary to the Science and Art Department:—

South Kensington Museum, London, S.W.
16th day of November, 1877.

Sir,—I am directed by the Lords of the Committee of Council on Education to transmit to you, for the information of your Society, the enclosed copy of a letter and its enclosures, received at this Department from the Colonial Office, with reference to a Juvenile Industrial Exhibition which it is proposed to hold next year at Ballarat.

I am to suggest that the announcement, regulations,

&c., of the proposed Exhibition might be published in the pages of the Society of Arts' *Journal*.

I am, Sir,
Your obedient servant,
Norman MacLeod.

P. Le Neve Foster, Esq., M.A., Secretary,
18 and 19, John-street, Adelphi, W.C.

[Enclosure No. I.]

Downing-street,
8th November, 1877.

Sir,—I am directed by the Earl of Carnarvon to tranmit to you a copy of a despatch from the Governor of Victoria with printed regulations, &c., connected with the Australian Juvenile Industrial Exhibition, which it is proposed to hold next year at Ballarat.

It will be seen that it is desired in the colony that the holding of the Exhibition should be made known in the United Kingdom.

I am, Sir,
Your most obedient servant,
(Signed) W. R. Malcolm.

The Secretary to the
Science and Art Department.

[Enclosure No. II.]

Sir G. F. Bowen to the Earl of Carnarvon.

Government-house, Melbourne, 10th August, 1877.

My Lord,—1. I have the honour to forward herewith, for your Lordship's information, copies of the regulations and other papers connected with the "Australian Juvenile Industrial Exhibition," which it is proposed to hold in the early part of next year, at Ballarat. This is the chief gold mining city in Victoria, and has, with its suburbs, a population of about fifty thousand (50,000) souls. It is also the centre of an important agricultural and pastoral district.

2. I have been requested to ask your Lordship to cause some of the enclosed papers to be so distributed as may make the proposed Exhibition known in the United Kingdom.

3. It will of course be understood that this Juvenile Exhibition at Ballarat has no connection with the International Exhibition which it is proposed to hold at Melbourne in October, 1879, a proposal which I reported to your Lordship by the last mail, in my despatch No. 102 of the 7th instant, and respecting which I shall make further communications hereafter.

I have, &c.,
(Signed) G. F. Bowen.

The Right Honourable the Earl of Carnarvon, &c.

[Enclosure No. III.]

Australian Juvenile Industrial Exhibition, Ballarat.

To be opened 15*th February*, 1878.

Patron.—His Excellency Sir George Ferguson Bowen, G.C.M.G.

Vice-Patrons—Hon. Graham Berry, M.L.A.; Hon. Francis Longmore, M.L.A.; Hon. W. C. Smith, M.L.A.; Hon. John Woods, M.L.A.; Hon Peter Lalor, M.L.A.; Hon. Henry Cuthbert, M.L.C.; Hon. R. Le P. Trench, Attorney-General; Hon. James Grant, M.L.A.; Hon. J. B. Patterson, M.L.A; Justice T. H. Fellows, Judge T. S. Cope, Judge Bindon, Chief Justice Sir W. F. Stawell, Judge Rogers, Judge Hackett, Judge Skinner, Sir Charles G. Duffy, Speaker of Assembly; Sir W. H. F. Mitchell, President of Council; Right Reverend Dr. Thornton, Most Reverend Dr. O'Connor.

President.—W. J. Clarke, Esq.

Vice-Presidents.—Sir Jno. O'Shannassy, M.L.A.; Ven. Archdeacon Potter; Hon. G. F. Belcher, M.L.C.; Hon. Jno. Cumming, M.L.C.; Dr. Hudson, J.P.; A. Fisken, Esq., J.P.; A. M. Campbell, Esq., J.P.; J. L. Currie, Esq.; R. Twentyman, Esq.; A. Chirnside, Esq.; Hon. R. D. Anderson, M.L.C.; Hon. F. T. Sargood; Sir C. McMahon, M.L.A.; Hon. Neil Black; Sir Geo. F. Verdon; Hon. C. J. Jenner, M.L.C.; Hon. Phillip Russell, T. Shaw, jun., Esq.; Robert Scott, Esq.; H. J. Browne, Esq.; R. Chirnside, Esq.; Hon. Robert Ramsay; Thos. McPherson, Esq.; Hon. Jas. Munro, M.L.A.; Hon. J. G. Francis; Robert Balding, Esq.; Alex. Bayne, Esq., J.P.; Henry Josephs, Esq., C.W.C.; G. R. Fincham, Esq., M.L.A.; John James, Esq., M.L.A.; H. Bell, Esq., M.L.A.; D. Brophy, Esq., M.L.A., J.P.; F. M. Claxton, Esq., Mayor City Ballarat; James Long, Esq., Mayor Ballarat East; A. K. Smith, Esq., M.L.A.; Hon. Joseph Jones.

Executive Committee.—Charles Seal, Esq., Chairman; H. R. Caselli, Esq., J.P., Deputy-Chairman; Alexander Hunter, Esq., Treasurer; James McDowall, Esq., J.P.; George Smith, Esq.; Jonathan Robinson, Esq.; William Evans, Esq.; J. C. Smith, Esq.; Peter Matthews, Esq.; Thomas Bodycomb, Esq.; Henry Smith, Esq., J.P.; James Buley, Esq.; C. J. Richardson, Esq.; William Proctor, Esq.; Joseph Flude, Esq.; R. M. Sergeant, Esq.; Jno. Whitehead, Esq.; James Campbell, Esq.; Hugh Reid, Esq.; William Benson, Esq.; James M. Main, Esq.; W. H. Keast, Esq.; G. C. Robinson, Esq.; Edwin Curtis, Esq.; George O. Preshaw, Esq.; John McCartney, Esq.; Charles C. Shoppee, Esq.; and Henry Bradbury, Esq.

Bankers.—Bank of Australasia.

Regulations for the Guidance of Intending Exhibitors.

Section A.—Under 21 years of age, at the time of applying for space.

Section B.—Apprentices not out of their indentures, whatever their age.

Section C.—Between the ages of 15 and 18 years.

Section D.—Under 15 years of age.

Section E.—Non-competitive Exhibits.

Class 1. Machinery of every description, mining, agricultural, and other implements, and models of same, also models models of mines and workings.

Class 2. Carriages, vehicles, and models of same.

Class 3. Building materials, decorations, and models of buildings.

Class 4. Furniture and household requisities in wood, inlaying, rustic, basket work, &c.

Class 5. Harness, leather, skins, furs, boots and shoes, and all articles in leather.

Class 6. Men's clothing, hats, &c., also materials for same.

Class 7. Ladies' dresses, millinery, children's dresses, underclothing, dressed dolls, and every description of plain and fancy needlework, knitting, netting, &c.

Class 8. Ladies' ornamental and artificial work, in wax, feathers, paper, wool, leather, or other material.

Class 9. Food, luxuries of consumption, confectionery, jams, jellies, preserves, cakes, biscuits, pastry, bread, butter, cheese, pickles, hams, bacon, &c.

Class 10. Instruments—Philosophical, mathematical; cutlery, tools, and all instruments in metal, glass, and other material.

Class 11. Musical instruments and musical compositions.

Class 12. Boats—steam, sailing, and rowing (not to exceed 30 feet), models of same, and life-saving apparatus.

Class 13. Fine arts, painting, drawing, modelling, sculpture, penmanship, printing, lithography, mapping, photography, bookbinding, and engraving.

Class 14. Jewellery, clocks, watches, and ornaments in the precious metals and minerals,

Class 15. Castings and fittings in brass, copper, zinc, iron, tin, and all metal wares, smiths' work, &c.

Class 16. Glass, pottery, and all articles of plastic ware.

Class 17. Toys of wood, metal, or other material, and models of every description.

Class 18. Pot plants grown from cuttings and seeds by exhibitors, and seeds of every description. Wardian cases, &c.

Class 19. Collections and devices in shells, mosses, dried ferns, sea weeds, animals, birds, insects, or any natural production.

Class 20. Turning and carving in stone, marble, ivory, bone, metal, wood, horn, compositions, or other materials.

Class 21. Textile fabrics, spun and raw silk, and wool, ropes, matting, brush ware, &c.

Class 22. Mineralogical and geological collections, chemicals, dyeing, tanning, artificial manures, &c.

Class 23. Essays, poems, and compositions on any subject.

Class 24. Articles not enumerated.

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1. The Executive Committee of the Australian Juvenile Industrial Exhibition invite the young people, of both sexes, all over the Australian colonies, to contribute articles of their own handiwork.

2. The Exhibition will be opened in Ballarat on or about the 15th February, 1878, and remain open about two months. All exhibits must be delivered at the Exhibition Building, Ballarat, on or before the 31st day of January, 1878, or shipped on that date if coming by sea from other colonies; exceptions will bo made for perishable articles, which will be received up to the day before opening of Exhibition.

3. Application for space must be made on or before the 31st day of December, 1877. Applicants must be under twenty-one years of age at the time of applying for space, except in sections B and E.

4. Forms of application for space, or any information, can be obtained from the Honorary Secretary, 5, Sturt-street, Ballarat, or from any of the agents advertised, either personally or by letter.

5. The Executive Committee will assert the right to limit space and to exclude any unsuitable, dangerous, or explosive exhibits, not forwarding or returning the exhibit.

6. Exhibitors can jointly make any article for exhibit, or exhibit any portion of an article separately; the joint work of apprentices can be exhibited from any establishment or workshop.

7. Exhibitors will not be charged for space, nor should more be applied for than required, and it is desirable that all granted should be occupied; a limited quantity of steam power will be supplied, if necessary.

8. Young people are invited to contribute models, working or otherwise, of any description, in any material, not to exceed one cubic yard of content.

9. The Executive Committee will take the greatest care of all exhibits, but cannot hold themselves responsible for loss, robbery, accident, damage by fire or otherwise, in transit, while in the building, or during the Exhibition.

10. Exhibitors may sell their exhibits under regulations to be made by the Committee, but no removal will be allowed during the time the Exhibition is open, without a special written order from the Honorary Secretary.

11. Medals in gold, silver, and bronze, will be awarded by the Executive Committee, on recommendation of the Judges, for exhibits of merit.

12. Sketches, drawings, photographs, or other reproductions of articles exhibited, will only be allowed upon the joint consent of the exhibitor and the Executive Committee.

13. Exhibits should be carefully packed to prevent injury, arranged and protected to preserve them from dust and exposure; glass cases must be provided by exhibitors, if required.

14. Arrangements will be made to carry exhibits by railway, steamer, or coach, at reduced rates, if possible.

15. Exhibits not claimed and removed within 14 days after the closing of the Exhibition, will be sold by public auction, and the net proceeds handed to the exhibitors.

16. The Executive Committee reserve the right to explain or amend these regulations, whenever it may be deemed necessary for the interests of the Exhibition.

Ladies and gentlemen are invited to give special prizes for any particular class of exhibit for the young people to compete for, which may consist of any useful or ornamental article, medals, or cash, which will be awarded by the judges. An early response is requested, stating the nature of prize and for what article, to enable a list to be published for information, and thus create competition. Please address the Honorary Secretary, who will give any further particulars required, and also take charge of the prizes.

R. D. BANNISTER,
Honorary Secretary.

Office of Exhibition,
5, Sturt-street, Ballarat.

MISCELLANEOUS.

INDIAN COTTON AND SILK.

The statement upon the moral and material progress of India, for the year 1875-76, devotes a brief space to the subject of the cotton and silk manufactures of the peninsula. In Bengal the cotton manufacture is carried on at the present time to a very limited extent. Three pieces were ordered by a native gentleman, for presentation to the Prince of Wales; each piece measured 20 by 1 yards, but the fineness of the texture was such that the weight was only $3\frac{1}{2}$ ounces. In the town of Bombay, and Coorla, a village in the neighbourhood, there were, during the year, 24 cotton mills working, containing 689,950 spindles, and 7,039. In the up-country districts eight mills were at work, with 125,153 spindles and 640 looms. Since the close of the year another mill, with 10,000 spindles, was opened, and six more were in course of completion, which would altogether raise the number of spindles to 963,983. These mills do a large trade in yarn and in the coarse cloth, and find ready markets for all they can produce. The number of steam gins was 2,585, being an increase of 206. In the number of presses licensed and worked in British territory there was a decrease of 28, of which 22 were hand-presses, and six presses worked by steam. The diminution in the number of full presses was confined to the capital, and was due to the increase of full pressing up country. Of 1,010,284 bales exported from the Presidency, more than 500,000 were full pressed before they reached Bombay. In connection with this subject, it is mentioned that there is at Nagpore, in the Central Provinces, an association of native gentlemen co-operating with societies in the Bombay Presidency, with the object of encouraging the trade in country-made clothes, to the exclusion of the European manufactures. The association does not aim at any profits at all, but the motive is said to be purely a patriotic support of the Indian manufacture; and the members wear, as far as possible, only country-made stuffs. This movement shows that tho decline of native manufactures is a popularly accepted fact. Berar is essentially a non-manufacturing district. The weaving industry, which in former days was the chief occupation of the inhabitants of the larger towns, has gradually given way before the importation of English and Bombay piece goods, and is now almost limited to coarse descriptions of cloth. There were altogether 29 full presses at work, which on an average pressed 7,357 bales of cotton. One press opened during the year was the first established under native management.

Various causes have combined of late years to affect the Bengal silk industry, namely, the growing preference in Europe for woollen fabrics, the competition of Chinese and Japanese silks, the increased production in Italy, and frequent attacks of the silkworm by an incurable disease. There was, however, some prospect of a revival in consequense of a failure during the year in France and Italy. Silk-weaving, although it has shared to some extent the fate of silk-spinning, is still an important industry in Bengal. A considerable impulse was given during the year to sericiculture in the Punjaub, by the establishment of a factory for reeling silk from the cocoon, and by the offer of annual prizes by a committee to producers of cocoons. The tussur silkworm being found to exist in considerable numbers in the several districts, operations were commenced for rearing the worm on a large scale, with a view to the possible development of a new industry in tussur silk.

THE MUTTON WINE OF THE MONGOLIANS, AND ANALOGOUS PREPARATIONS OF THE CHINESE.*

By Dr. D J. Macgowan,

Of Shanghai.

Chinese medical writers make little distinction between *Materia medica* and *Materia alimentaria*. The *Pun-tsao* ascribes therapeutic properties to all articles that are used as food. Nearly all portions of animals, the human frame included, are supposed to be efficacious in the treatment of disease. In their preparation they are for the most part subjected merely to ordinary culinary treatment. The exceptions consist of animal substances, which are macerated in fermented or distilled liquors. To these they apply the term *chiu*, commonly rendered "wine" by sinologues. Hence we find in the *Pun-tsao:* "Mutton wine, dog wine, deer wine, deer-horn wine, tiger-bone wine, black snake wine, flowery snake wine, *hi* snake wine, and tortoise wine."

Alcohol is designated in the *Pun-tsao* as ah-lih-kih, which indicates the Arabian origin in China of the art of distillation. It is seldom used as a pharmaceutical menstruum, their distilled *chiu* being employed as a solvent for articles used as medicines.

These animalised liquors, if that term be allowable, are for the most part extemporaneously prepared—a few only are to be had in apothecary shops ready made; such are several kind of snake wines. These latter are used in palsy. In Kwang-si the fermenting agent is a species of wild grass. The snake thus employed appears to be peculiar to the mountains of that province. To assure purchasers that the article is genuine, a strip of the skin of the animal is fastened to the top of the containing vessel. This wine is in high esteem as an anthelmintic, and as an antidote to malaria. Wuhu on the Yang-tse produces a snake wine which is in high repute. An adder wine is used in paralysis and insanity. There is a long edible snake spoken of as found in Kiang-si, which, being dried and smoked, is pared off in thin slices, like smoked beef, and is found a convenient condiment by travellers.

The wine in which tortoise has been macerated is described as useful in chronic bronchitis. Cases of ten and twenty years' standing have, says the *Pun-tsao*, yielded to this remedy.

Dog wine is described as very heating and stimulating.

The officinal *mutton wine* of the Pharmacopœia is, in fact, made of goat's flesh, the goat and sheep being often confounded; the latter animal does not appear to have been known to the ancient Chinese.

Various species of sheep are described in the *Pun-tsao*, or Chinese Pharmacopœia, which are not recommended for macerating in wine. Among these is the great-tailed sheep of the Kwan-lun mountains, the caudal extremities of which are stated to weigh thirty pounds, rendering locomotion difficult. It is added that these adipose tumours require to be removed annually, else the animal will die. Their tails are cut open, the fat cut out, when the edges are brought together by a suture.

Sheep and goat wines are directed to be prepared in the following manner:—Take ten catties (1 catty = $1\frac{1}{3}$ lb.) of soaked rice, seven catties of goat or sheep flesh, fourteen onions, one Shan-tung cabbage, and a catty of almond kernels. Mix them well together, and let the mixture stand and brew without malt for ten days, at the end of which time a small quantity of liquor is produced; it is a sweet and unctuous liquor, or mutton wine. This is the formula adopted in the preparation of all the animal liquors above named.

"Mutton or goat wine is a great restorer of the constitution; it strengthens the stomach, the kidneys, and testes," according to the *Pun-tsao*.

Having many years ago met with a jar of mutton wine, which its owner, a Mongolian mandarin, greatly prized, I instituted inquiries respecting its mode of preparation and uses among the nomads of the north, but without success, until a few months ago, when the Rev. J. Gilmour, in response to a request that I made of him, courteously undertook the investigation of the matter, and was at the pains to have the article prepared under his own supervision.

The following were the ingredients:—One sheep, forty catties of cow's milk wine; one pint of skim milk, soured and curdled; eight ounces of brown sugar; four ounces honey; four ounces of fruit of dimocarpus (*Euphorbia Litchi*, Desf.); one catty of raisins, and half a dozen other drugs weighing in all about one catty. The sheep must be a castrated male, and two years old, neither more nor less.

Plant necessary for distillation.—One large pot (cast iron), one wooden half-barrel opened at bottom,* one smaller pot (cast iron), one earthenware jar, felt-belts, cow-dung, fire.

Process.—Set the boorher on the large pot, caulk the joining first with paper, then daub the outside with cow-dung and ashes. Make the boorher air-tight by plastering it all over outside with cow-dung.

Pour in the wine, add half the raisins (*i.e.*, ten ounces), cut or crushed, half the brown sugar, the pint of skim milk, and the bones of the sheep's legs from the knee downward, after breaking them open.

From the other bones strip all the fat and most of the flesh, leaving them fleshy. Hang them, head and all, inside the boorher, high enough to be beyond the reach of the wine, and low enough to be out of reach of the pot above. Break up the medicines into small pieces (do not pound them), and put them into the earthenware pot. Into that pot put also the honey, white sugar, dragon's eye, and the remaining half of the brown sugar and raisins; suspend the earthenware pot in the centre of the boorher, put on the pot above, and make the joining air-tight by paper, cloth, and felt bands. Apply fire to the great pot. When the upper pot feels warm to the touch, fill it with cold water and stir it. When the water becomes too hot to touch, ladle it out and fill up with cold water. When this second potful of water becomes too hot for the hand, slacken the fire, take off the upper pot, and the earthenware pot will be seen full of a dirty brown liquor boiling furiously. Take out the earthenware pot, pour off the liquid, replace the earthenware pot, replace the upper pot, fill with cold water. When this potful of water becomes hot the whole thing is over. The earthenware

* From the *Pharmaceutical Journal*. First published in *Journal of the North China Branch of the Royal Asiatic Society*, vol. vii., 1873, p. 235.

* This is about two feet high and tapering. At the bottom it is large enough to sit on the rim of a big pot; at the top it is small enough to let the small pot sit in it without falling through. It is called *Boorher*.

pot is again about half filled, pour it off, and let it cool. When reasonably cold put it up in jars, and close them with the membrane of ox or sheep's bladders.

Remarks.—The great bulk of the flesh of the sheep is not used, nor any of the fat; all the marrow-bones are broken open. The skull is not broken open, nor the tongue extracted from the head. At the end of the process the mutton on the bones is cooked, but tastes badly. The quantity of cow's milk wine in the pot is not much diminished, but the strength is gone, and what remains is good for throwing away only.

Time of making.—"It should not be made before the seventh or eighth Chinese month. This was made on the 12th of the ninth month. It should not be used before the 11th or 12th Chinese month. None but aged people should drink it. It may be taken daily in one, two, or three small Chinese winecupfuls, till finished. The first winter the patient uses it, not more than two or three catties should be drunk. If found to agree with the patient, and if taken a second winter, another catty may be added, *i.e.*, first winter, two and a half, second, three and a half, third, four and a half catties. If kept till spring it becomes useless, if not dangerous. Many people use it, but few take it more than one winter. Its use is (seemingly) to repair any manifestations of weakness arising from old age."

"*Case.*—Rev. J. Gilmour's teacher, when fifty years old, was afflicted with a shaking of the head from right to left. He drank two or three catties of mutton wine in the dead of winter, recovered, and is now all right."

The liquor thus prepared has a very strong odour of mutton; it is sweetish and unctuous. Specific gravity, 0·98873. Alcoholic per-centage, 9·14.

GENERAL NOTES.

Banana Cultivation at Panama.—There has been a largely increased cultivation of the banana during the past two years. An enterprising German has cleared and planted a large tract of land bordering on the railway about a mile from Colon, with this fruit. The wet rich alluvial soil of the isthmus is peculiarly adapted to the production, both in quantity and quality, of the banana. From this property as much as twelve hundred trees are exported monthly from Colon to New York, where they sell readily at an enormous profit. More than two hundred persons, chiefly Jamaicans, are employed on this estate.

Mechanical Fan.—A novel instrument for producing a refreshing current of air in a room, capable of being used in a lady's hand, in lieu of the usual fan, has been devised by General Franzini. By means of clock-work in the handle, set in motion or stopped at will, by pressing a button, an oval plate is caused to revolve; on its longer axis is an oval frame, in shape and size like that of the hand looking-glasses commonly in use. The revolving plate may be either a plain metallic sheet or a piece of plate looking-glass, and the frame is susceptible of any amount of ornament. The lady is thus saved the exertion of waving the fan in her hand. A similar instrument of a larger kind may by placed on a table, concealed, if desired, by a bouquet of flowers.

Zulla Cultivation in Minorca.—An important change in the agricultural system of Minorca has been gradually effected since the introduction of the "zulla," *Edysarum coronarium.* Formerly all the attention of landlords and farmers was fixed upon the cultivation of grain, chiefly wheat, and the products of cattle were considered of little importance. Now the cultivation of zulla has taken yearly more importance, and a great part of lands which were formerly destined to corn fields are now employed for pastures. Hence has arisen an important augmentation of the number of cattle on all those farms where the zulla is cultivated, and the exports of cattle and the products of cheese have increased to a remarkable extent.

Corsican Exports.—According to Consul Shortt's report, among the exports there is one that would appear strange to an Englishman; there are annually between 350,000 and 400,000 blackbirds *(merles)* sent to the Continent; they come in vast numbers each winter to feed upon berries of the myrtle and arbutus, with which the mountains are covered. In the month of December they become very fat, and the flavour and perfume given by their food cause them to be much esteemed by the *gourmets* of Paris. *A paté de foie de merle* is a great delicacy.

NOTICES.

NOTICE TO MEMBERS.

It is specially requested that, in case of any irregularity or delay in the delivery of the *Journal*, notice may be sent at once to the Secretary.

THE LIBRARY.

The following works have been presented to the Library:—

A Summer Trip to the Island of St. Michael, The Azores, by Rupert Swindells. Presented by the author.

Presented by the Meteorological Department of India.

Report on the Meteorology of India in 1875, by Henry F. Blandford.

Indian Meteorological Memoirs. Vol. I., Part I.

Report on the Administration of the Meteorological Department of the Government of India in 1875-6.

Report of the Vizagapatam and Backergunge Cyclones of Ooctober, 1876, by J. Elliott, M.A.

Presented by Dr. Von Steinbeis.

Gewerbliches Fragenbuch verfaszt von Dr. Karl Karmarsch.

Jahresberichte der Handels-und Gewerbekammem in Württemberg für das Jahr. 1876.

Die Industrielle Entwicklung im Königreich Württemberg von Regievungsrath. L. Vischer.

Die Gewerblichen Fortbeldungsschulen in Württemberg.

MEETINGS FOR THE ENSUING WEEK.

Mon.... **SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures). Mr. W. Arnot, "Manufacture of Paper." (Lecture I.)
Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Discussion on the "Pruning of Coniferous Trees."
Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. 1. Commander G. C. Musters, R.N., "Notes on Bolivia." 2. Mr. C. R. Markham, "The still Unexplored Parts of South America."

Tues.... Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Renewed discussion on "The Progress of Steam Shipping."
Anthropological Institute, 4, St. Martin's-place, W.C., 8 p.m. 1. Mr. F. M. Hunter, "Notes on Socotra." 2. Mr. Alfred Simson, "Notes on the Zâparos." 3. Rev. S. J. Whitmee, "The Malays and Polynesians."

Wed.... **SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Prof. Graham Bell, "The Telephone."

Fri.......Volunteer Sick Bearers' Association (at the House of the Society of Arts), 7 p.m. Lecture by Surgeon-Major Staples.

Sat.......Working Men's Club and Institute Union (at the House of the Society of Arts), 4 p.m. Prof. Huxley, on "Technical Education."
Physical Science Schools, South Kensington, S.W. 3p.m.

ADULT INSTRUCTION THROUGH PUBLIC MUSEUMS.

(Subsidised by Parliament.)

The following results, giving important information bearing on public education, are obtained as correctly as possible, from inquiry and Parliamentary returns, in the hope that they may hereafter be officially collected and published periodically, like the Registrar-General's returns. The number of visitors for the month of October, 1877, are stated. When they are counted by sight the letter "S" is used, when by turnstile the "M":—

INSTITUTIONS.	Amounts voted in 1877.	Number of Visitors in October.	How counted.	OBSERVATIONS.
1. British Museum	£ 109,990	44,520	S	Return refused. Open Mondays, Wednesdays, Fridays, and Saturdays. Closed, except to students, on Tuesdays and Thursdays. (1)
2. National Gallery, Charing-cross	6,976	..	S	Open Mondays, Tuesdays, Wednesdays, and Saturdays. Closed on Thursdays and Fridays. Open from 10 to 6. (2)
3. Kew Gardens and Museum	22,622	23,136	S	Open on Sundays and week days. (3)
4. South Kensington Museum	38,922	65,769	M	Open morning and evening till 10, on Mondays, Tuesdays, & Saturdays. Students' days—Wednesday, Thursday, & Friday, 6d. entrance. Open from 10 till Sunset.
5. Bethnal-green Museum	7,600	44,413	M	Ditto. (5)
6. National Portrait Gallery, South Kensington	2,000	..	M	Return refused. Open daily except Sundays. (6)
7. School of Mines and Mining Record Office, Geological Museum, Jermyn-street	8,997	3,100	M	Open daily, except Sundays and Fridays, and in the evenings till 10 of Monday, Tuesday, and Saturday. (7)
8. Patent Office Museum, South Kensington	..	18,195	M	Open daily, except Sundays. (8)
9. Edinburgh National Gallery	2,100	6,737	M	(9)
10. Edinburgh Museum of Antiquities	..	6,267	M	(10)
11. Edinburgh Museum of Science and Art	10,998	28,290	M	Open daily (10 a.m. to 4 p.m.) except Sundays, and Friday and Saturday evenings (6 to 9). Students' days—Monday, Tuesday, & Thursday; admission 6d.; other days, admission free. (11)
12. Edinburgh Botanic Gardens	1,750	3,692	M	(12)
13. Dublin Museum of Natural History	1,762	7,666	M	Open daily, & in the evening. (13)
14. Glasnevin Botanical Gardens and Museum	2,224	17,350	M	Open daily, including Sundays. (14)
15. National Gallery of Ireland	2,389	..	M	(15)
16. Museum of Royal Irish Academy, Dublin	300	..	M	(16)
17. Zoological Gardens, Dublin	500	7,220	M	Open daily, including Sundays. Number of visitors in July, 15,281. (17)
18. Tower of London	1,590	26,441	S	Open daily, except Sundays. (18)
19. Royal Naval College, including Greenwich Painted Hall	38,051	26,404	S	Open daily, including Sundays. (19)
20. Royal Naval Museum, Greenwich	1,055	4,414	S	Open daily, except Fridays and Saturdays. (20)
21. India Museum, South Kensington	..	1,776	M	Paid for by Indian Government. Open on Mondays, Tuesdays, Fridays, and Saturdays, 1d. admission; on Wednesday and Thursday, 6d. admission. (21)
22. Hampton Court Palace	7,475	5,521	..	Open on Sundays, and on week days except Fridays. (22)

(9) (10) (12) (16) No information as to opening.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,306. Vol. XXVI.

FRIDAY, NOVEMBER 30, 1877.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

INDIAN COMMITTEE.

A meeting of this committee was held on the 26th November, at half-past four o'clock. Present—Mr. Hyde Clarke (in the chair), Mr. Andrew Cassels, Mr. Hendriks, Mr. Maitland, Mr. J. T. Wood, with Colonel Hardy, Secretary for the Indian Section. The committee had under consideration the programme for papers in the Indian Section this Session, and noted a list of subjects for discussion. The evening of 1st February next was allotted to Sir Joseph Fayrer, M.D., K.C.S.I., for a paper on "The Destruction of Life in India by Wild Animals;" and the 22nd February, to Mr. W. T. Thornton, C.B., of the India-office, for a paper on "Irrigation Regarded as a Preventive of Indian Famine."

AFRICAN COMMITTEE.

A meeting of this committee was held on the 28th November. Present—Admiral Sir Erasmus Ommanney, C.B., F.R.S. (in the chair), Mr. W. Babington, Mr. L. Bergtheil, Mr. H. Blaine, Mr. Hyde Clarke, and Mr. William Hawes, with Dr. R. J. Mann, Secretary to the Indian Section. The arrangements for the Session were taken into consideration.

SECOND ORDINARY MEETING.

Wednesday, November 28th, 1877, Prof. George Carey Foster, F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Bramston, John, Colonial Office, Whitehall, S.W.
Carteighe, Michael, F.C.S., 180, New Bond-street, W., and 81, Mornington-road, N.W.
Cullen, William Hart, jun., 13, Victoria-road, Holloway, N.
Hewan, Archibald, M.D., 9, Chester-square, W.
Kenrick, William, Mayor of Birmingham.
Postans, Arthur William, F.C.S., 35, Baker-street, Portman-square, W.
Reid, Patrick Sandeman, 20, John-street, Adelphi, W.C.
Sabel, Ernest E., F.R.G.S., 85, Cannon-street, E.C., and 185, Maida-vale, W.
Sabel, Paul, 85, Cannon-street, E.C.
Smith, James S., 12, Worship-street, E.C.

The paper read was—

THE TELEPHONE.

By Professor A. Graham Bell.

Telephony is receiving at the present time a great deal of attention from men of science all over the world, and it is my intention to-night to try and give you a short account of the means by which sound can be produced at a distance by electrical means. There are probably many here present who may recollect the early telephonic experiments made in this country by the late Sir Charles Wheatstone. These experiments were repeated, and, perhaps, improved upon, in America, by Prof. Henry, of the Smithsonian Institute, and others. I may direct your attention for a moment to one of these earlier telephonic experiments in America. Two pianos were placed, one on each side of the road. A long deal rod was taken across the street, from the window of one house to that of the other, and the two ends of the rod were connected to the sounding-boards of the pianos. Under these circumstances, when a person played the piano in one house, the piano in the other house seemingly played by itself. The vibration of the sounding-board was communicated mechanically through the long wooden rod, and, at the other end of this wooden circuit, the sounding-board of the other piano was set into vibration, and the strings of the piano, which were in unison with those of the first one, were thrown sympathetically into action, and produced music.

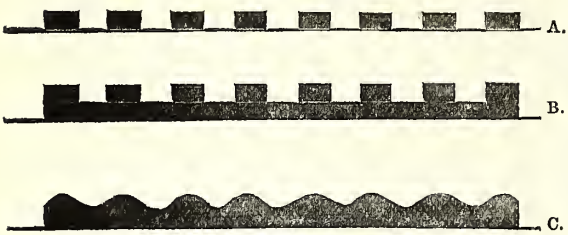
Another telephonic experiment that I shall direct your attention to may be seen going on in the streets of London on almost any day. You may see persons in the streets exhibiting what is called the telephone, consisting of a small membrane with a thread or a string attached to the end of it, and at a distance of 100 yards or so there is another membrane. The two membranes are united by this thread or string, and if you talk to one of these membranes it is thrown into vibration, and that vibration is mechanically communicated through the string to the other, and the sound is produced in the other membrane. But there is a difference between the early telephonic experiments and those I wish to direct your attention to to-night. If you observe for a moment the *modus operandi* of the thread telephone, you will see that there are two membranes which control one another's action through the vibration of a string. One of these membranes is forced to vibrate; it pulls the other by the string and releases it, and the two vibrate together. In this case, then, the sound is mechanically conducted along the string, but in electric telephony the sound is not communicated along the wire at all. It exists in the wire as a current of electricity, which produces, *de novo*, the vibration of a sound at the receiving end of a circuit.

In examining the means by which sound can be electrically produced, I would direct your attention to several distinct species of what may be called telephonic currents of electricity. For this purpose I will have the lights lowered, and a graphical representation of those currents will be thrown upon the screen. I distinguish three varieties of telephonic currents, which I will designate intermittent, pulsatory, and undulatory. You have

these three varieties shown in the three lines of the diagram, the upper one being the intermittent, the second, the pulsatory, and the third, the undulatory. The horizontal line indicates the zero of the currents, and the dark lines are impulses of electricity. When these lines are above the zero they indicate positive impulses, when they are below, they indicate negative impulses of electricity. The vertical thickness of the electrical line from the zero indicates the intensity of the current at the point observed, so you will see that the characteristic of an intermittent current is the alternate presence or absence of electricity from the circuit. The characteristic of the pulsatory current is a pulsatory change in the intensity of the continuous current; but the undulatory current, to which your attention will be chiefly directed to-night, is a continuous current of electricity, the intensity of which varies gradually, and in a manner proportional to the varying velocity of a particle of air.

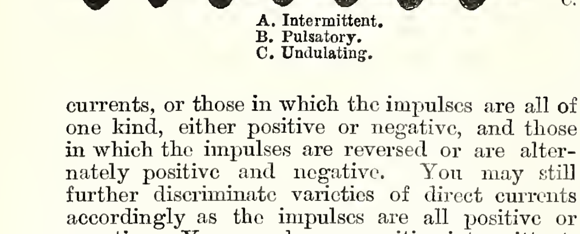
The three radical varieties of telephonic currents may be sub-divided into direct and reversed

Direct.



A. Intermittent.
B. Pulsatory.
C. Undulating.

Reversed.



A. Intermittent.
B. Pulsatory.
C. Undulating.

currents, or those in which the impulses are all of one kind, either positive or negative, and those in which the impulses are reversed or are alternately positive and negative. You may still further discriminate varieties of direct currents accordingly as the impulses are all positive or negative. You may have a positive intermittent, or a negative or reversed intermittent current, so that you have nine varieties of telephonic currents.

So far as I have been able to find, all previous experimenters in this branch of science have used intermittent or pulsatory currents in their attempts to produce sound, and I believe that I am the first to conceive of the employment of undulatory currents, whereby not only a noise or musical sound may be produced electrically, but sound of any kind—the *timbre* of the sound as well as the pitch and force of it being preserved.

The question will naturally arise in your minds, how can these currents of electricity be produced? It will be my object to-night chiefly to speak of the undulatory current and the means of producing it; but I may here state that I have not yet been able to produce a true undulatory current, and the methods which I shall show you to-night are only approximately undulatory. I shall pause, then, first, to consider one of the means by which intermittent currents of electricity can be produced, and I will have thrown on the screen an illustration of an apparatus devised by Helmholtz, consisting of a tuning-fork placed between the poles of an electro-magnet; a platinum wire attached to one of the prongs of the tuning-fork dips into a cup of mercury, thus completing a voltaic circuit. So long as the platinum wire touches the mercury a current of electricity traverses the circuit, passes through the fork, and then through the electro-magnet, and so to the other pole of the battery. Under these circumstances, so long as the circuit is closed, the soft iron core of the electro-magnet attracts the prongs of the tuning-fork, and the result is that the prongs are separated: the result of that is that the platinum wire is lifted out of the mercury; the moment it leaves the mercury the circuit is broken, the current of electricity ceases, the magnetism of the magnet ceases, the attraction of the iron core ceases, and the fork springs back by its own elasticity. Hence, the moment the platinum wire touches the mercury again, the prongs are again attracted apart, and are again released, so that the result is that the fork is thrown into continuous vibration, and at every vibration it makes and breaks the voltaic circuit, thus causing an intermittent current of electricity.

The means by which a musical tone can be produced by means of this intermittent current of electricity will be shown in the next illustration, which is a fork, also arranged by Helmholtz, by which one tuning-fork is made to communicate its vibrations to another fork of the same pitch, by means of an electrical current conveyed through a wire. By the use of a resonator placed in front of the second fork, you can reinforce the sound and make it louder or softer, by opening or closing the orifice of the resonator. An arrangement by Helmholtz will next be shown, by means of which a number of tuning-forks are set in simultaneous vibration by the action of one fork dipping into mercury, so that you have a large number of musical tones produced simultaneously from these forks. Helmholtz made a very remarkable experiment with these forks, varying their loudness by resonators, so as to combine the musical tones in different proportions, and the result was that he was enabled to copy the *timbre* of sound. He was able to produce by this external reinforcement of the forks the effects of certain vowel sounds, for instance, *oo* or *ah*, different forks being reinforced in different degrees.

I shall now show you the diagram of an apparatus for the production of an approximately undulatory current of electricity. I have here a harp of steel rods attached to the poles of a powerful permanent magnet, and the same arrangement is repeated at the other end of the circuit. Between the rods of this harp we have at each end an electro-magnet.

We know that when we move a magnet in the neighbourhood of an electro-magnet, we induce in the coils of the electro-magnet a current of electricity, the intensity of which is proportional to the velocity of the motion of the magnet; and not only so, but the kind of current, or its polarity, depends on the direction of the motion of the magnet. If I move my magnet downwards, I produce, say, positive electricity; and then, on the other hand, if I move it upwards, I produce negative electricity, so that it is evident to you that, when we vibrate a permanent magnet in front of an electro-magnet, we produce a reversed current in the electro-magnet, and the intensity of the current is proportional to the velocity of the moving body. Hence, we have our undulatory current of electricity. This undulatory current may be utilised to produce a sound at the distant end of the current in the following way. Let us suppose, for instance, that we have these two harps, that we pluck with the finger one of these rods; it vibrates, and produces a certain musical tone. In vibrating, we have an undulatory current of electricity produced, which traverses the circuit and passes round the coil of the distant electro-magnet. What is the result there? The result is, that this electro-magnet alternately attracts and repels the rods about it, the positive current attracting, and the negative current repelling them; so that when an undulatory current traverses it we have a succession of positive and negative impulses, and the soft iron core alternately attracts and repels the rods above it, and the rod which is in unison with the one agitated at the other end will be thrown into vibration. So that, if you were to play a tune upon this harp, the corresponding rods at the other end would be thrown into vibration, and the tune would be reproduced. But you will observe that the vibration of this harp is not communicated through the wire mechanically; as in the case of the piano experiment that I have referred to; but the vibration of the rod creates or induces a current of electricity, which current traverses the wire—of course, with the speed of electricity—and will go to any distance, so that instead of having one of these pianos on each side of the road you may have them hundreds of miles apart, and a telegraph wire between them, and play one piano, and the other will appear to play by itself.

If I were to show you Helmholtz's apparatus for the artificial production of vowel sounds, you would see that certain *timbres* of sound were produced by causing the tuning-forks to sound simultaneously, with different relations of force. By the arrangement just described we can cause certain of the rods of the harp to vibrate with certain relations of force. For instance, if I pluck one of these rods very forcibly, the current of electricity produced will be very intense, because the intensity of the current depends on the velocity of the moving body. Hence, when you vary the amplitude of the vibration you vary the intensity of the current. Accordingly, if you pluck one of the rods very forcibly, you will have an intense current produced, and the corresponding rods will be thrown into vibration forcibly, but if you pluck the rod gently a feeble current will be produced, and the rod at the other end is thrown into vibration feebly. If you sound a number of these rods simultaneously, with different relations of force, you will find the rods of the corresponding harp thrown into vibration, with corresponding relations of force. So that if you can produce a vowel sound by vibrating simultaneously a number of these rods, you can transmit a current of electricity which will produce the same sound from the harp at the other end of the wire. If you sing into a piano, keeping the pedal down so as to leave the strings free to vibrate, you will find that not only is the pitch of your voice echoed back to you from the piano, but also an approximation to the quality of the vowel. If you sing *ah* or *oo* you will find an approximation to these sounds produced from the piano. And the theory shows that if the piano had a very much larger number of strings to the octave, we should have not an approximation but a *fac-simile* of the vowel sound. When you sing the sound into the piano, certain of the strings are set in vibration sympathetically by the voice, with different degrees of amplitude, and the result is that you have these strings going on vibrating after the voice has ceased, with the result that the force and the vowel sound is echoed back.

The next illustration shows you my first form of articulating telephone. If you had a large number of steel rods to the octave, and were to speak in the neighbourhood of such a harp, the rods would be thrown into vibration with different degrees of amplitude, producing currents of electricity, and would throw into vibration the rods at the other end with the same relative amplitude, and the *timbre* of the voice would be reproduced.

However, there are still simpler methods of producing undulatory currents of electricity, and the best way of showing you the method of producing the required current will be to trace the various steps by which the present telephone has grown from the apparatus I have just shown you.

You will observe the effect produced upon the line of wire by the vibration of two of the rods of the harp I have spoken of; and in the next illustration I show you the effect of vibrating a number of permanent magnets simultaneously over an electro-magnet.

[Professor Bell here described in detail, and showed by a diagram, the result of the combined vibrations of two notes forming a major chord, the ratios of the vibration being as 5 to 4, and the resultant curve being the algebraic sum of the two.]

The effect is, when you vibrate more than one of these rods simultaneously, to change the shape of the electrical undulation, and a similar effect is produced when a battery is included in the circuit. In this case the battery current is thrown into waves by the action of the permanent magnets. Hence, you will see that the resultant effect on the current of a number of musical tones is to produce a vibration which corresponds in every degree to the moving velocity of the air. Suppose, for instance, you vibrate two rods in the harp, you have two musical notes produced; but of course if you pay attention to a particle of air, it is impossible that any particle of air can vibrate in two directions at the same time; it follows the resultant form of vibration. One curve would show the vibration of a particle of air for one musical tone, the next one for another, and the third the resulting motion of a particle of air when

both musical tones are sounded simultaneously. You have, by this apparatus, the resultant effect produced by a current of electricity, but the same resultant effect could be produced in the air. In order to show you the resultant vibration of the air from different sounds, I shall put another illustration on the screen. This shows, not the variation of intensity of a current of electricity, but the variation of the velocity of a moving particle of air; and the curves now on the screen represent graphically the movements of air for certain vowel sounds. They have not been theoretically calculated, but are actually tracings produced by the voice itself. Of course, we all know the instrument entitled the phonautograph, and these curves were drawn by an improved form of phonautograph. There was a cone into which you spoke, which condensed the air from your voice; at the small end of the cone, you had a stretched membrane, which vibrated when a sound was produced, and, in the course of its vibration, it controlled the movement of a long style of wood, about 1 ft. in length, and these curves were drawn by the style upon a surface of smoked glass, which was dragged rapidly along. I myself uttered the vowels that are here shown, viz., *e*, *ay*, *eh*, *ah*, *aah*; these vowels were sung at the same pitch and with the same force, but you will observe that each is characterised by a shape of vibration of its own. In fact, when you come to examine the motion of a particle of air, there can be no doubt that every sound is characterised by a particular motion. It struck me that if instead of using that complicated harp, and vibrating a number of rods tuned to different pitches, and thus creating on the line of wire a resultant effect, we were at once to vibrate a piece of iron—to give to that piece of iron not the vibration of a musical tone, but to give it the resultant vibration of a vowel sound, we could have an undulatory current produced, directly, not indirectly, which would correspond to the motion of the air in the production of a sound. The difficulty was, however, how to vibrate a piece of iron in the way required. The following apparatus gave me the clue to the solution of the problem in the attempt to improve the phonautograph:—I attempted to construct one modelled as nearly as possible on the mechanism of the human ear, but upon going to a friend in Boston, Dr. Clarence J. Blake, an aurist, he suggested the novel idea of using the human ear itself as a phonautograph, and this apparatus we constructed together. It is a human ear. The interior mechanism is exposed, and to a part of it is attached a long style of hay. Upon moistening the membrane and the little bones with a mixture of glycerine and water, the mobility of the parts was restored, and on speaking into the external artificial ear, a vibration was observed, and after many experiments we were able to obtain tracings of the vibration on a sheet of smoked glass drawn rapidly along. Many of those were very beautiful, and I am sorry I have not any of them here to-night to show you, but as it is foreign to our subject, it is, perhaps, as well. I would merely direct your attention to the apparatus itself, as it gave me the clue to the present form of telephone. What I wanted was an apparatus that should be able to move a piece of iron, in the way that a particle of air is moved, by the voice. It struck me in the course of these experiments that there was great disproportion between the tissue of the membranes and the bones that were moved by the membranes, and that if such a thin and delicate membrane could vibrate a mass of bone, so disproportionate in size and weight, perhaps a membrane might be able to vibrate a piece of iron in the way required. I therefore constructed a second form of articulating telephone, founded on the first apparatus by which I was, at the time of these experiments, producing undulatory electricity for the purpose of producing musical tones. It was similar to the rods shown you before, except that instead of being attached to a permanent magnet it was attached to one pole of an electro-magnet, and magnetised by means of a battery current. A current being passed through the coils of the magnet this piece of iron became magnetic, and a rod attached to one pole would of course become magnetic also, as if attached to a permanent magnet, so that, on vibrating this rod in any way whatever, the battery current was put in operation, and the corresponding rod at the other end thrown into vibration. I, therefore, took this apparatus, and instead of clamping the rod firmly, it was attached loosely to one extremity of the magnet, and the other end was attached to a stretched membrane of goldbeater's skin; and the same at the other end. The idea was that on speaking to this membrane, it would be thrown into vibration, and cause the vibration of the piece of iron, that in fact the iron would follow the motion of the membrane, that is, of the particles of air; it would, therefore, induce an undulatory current of electricity the intensity of which would vary with the motion, and at the other end the intensity of the magnetic attraction would vary in a similar way; so that the piece of iron at the other end, being attracted and repelled in a varying manner, would be thrown into vibration, copying the motion of the first, and it in turn would cause the motion of a second stretched membrane, which would move the air in the neighbourhood, and we should thus have a sound produced. The idea was, that not only would the two pieces of iron vibrate together, but the form of the vibration would be the same, so that on speaking in the neighbourhood of one membrane we should have a fac-simile of the sound produced at the other end. The apparatus was constructed, but the results were rather unsatisfactory. My friend, Mr. Thomas Watson, who assisted me, however, asserted that he could hear a very faint sound proceed from the second membrane when I spoke in the neighbourhood of the first. Encouraged by this fact, I varied the apparatus in a number of ways, and eventually produced three distinct forms of apparatus, which were exhibited at the Centennial Exhibition. I came to the conclusion that this piece of iron was probably rather too heavy to be set in vibration by the membrane, and I therefore made it as light as possible; in fact, I took a piece of steel spring, only about the size of the pole of the electro-magnet itself, and glued it to the centre of the membrane. Upon constructing two of these instruments, there was no mistake at all that articulate speech was produced; but it was of a very

imperfect nature. When a person spoke or sung into one of these instruments, you could distinctly hear the tones of the speaker's voice at the other end, and oould recognise that there was articulation there, and when you knew the sentence that was uttered, you could recognise the articulation, and it seemed strange that you could not understand what it was at first. The vowel sounds seemed to be copied very fairly, but the consonant sounds were entirely alike.

Another form of apparatus constructed at this time for producing an undulatory current, I have a photograph of, but it is a different size to the others, and cannot be thrown on the screen. It consists of one portion of the apparatus turned horizontally; attached to the membrane of gold-beater's skin is a little bit of cork carrying a platinum wire, which dips into a cup containing water. We know that water offers an enormous resistance to the passage of an electrical current. If you place two wires in water, separated by a slight distance, the resistance offered by the water is very great; but if you bring the wires nearer together, the resistance becomes less and less, so that the current of electricity becomes stronger and stronger, and when the two wires can be put in actual contact the resistance of the water may be ignored altogether. Hence you can see that by vibrating two wires to and fro in a liquid of high resistance included in the circuit, the battery current can be thrown into waves, and the resulting current may be considered as approximately undulatory; and with this form of apparatus I was able to produce articulate sounds. But it was no improvement on the first. I produced the effect of articulate speech by vibrating the conducting wire in this way in pure water, in water acidulated with dilute sulphuric and other acids, in salt and water, and in a number of other liquids. I also produced the same effect by vibrating a solid of high resistance in a liquid of low resistance. Instead of a platinum wire dipping into water, I had plumbago dipping into mercury. The plumbago offered a good deal of resistance to the passage of the current, but as it dipped into the mercury it offered less and less, and by having a very small piece of plumbago vibrating in the mercury, the current was varied in a manner approximately undulatory, and articulate effects were produced when this apparatus was used as a receiving instrument.

I found, however, that the best means I could devise for producing an undulatory current was the apparatus I will now show you, but it did not serve well as a receiving instrument, and I was therefore led, after many experiments, to construct another form of receiving instrument, keeping this for transmission.

This [a diagram of the instrument was thrown on the screen] is one of the forms shown in the Centennial Exhibition. On speaking into this, and listening to the other, articulate sounds were heard very distinctly.

The next illustration shows the form of receiving instrument to which I was led. It consists of a hollow box of iron, with the electro-magnet inside, and a thin diaphragm of iron laid on the top as a lid. Upon resting the ear closely against this diaphragm, articulate sounds were very clearly perceived, when the first instrument, as shown at Philadelphia, was used as a transmitting instrument. I was so convinced, from these experiments, that the inductive method of producing an undulatory current was the best method, that I determined to vary the construction of the first form of apparatus, and I gradually varied the size and power of my magnet, and the size and thickness of the iron spring attached to the membrane, and the size of the coil. I found, as I diminished the size of the coil, the resulting sound at the other end became very much louder; in fact, I found there was no advantage in using a coil that extended beyond the centre of the magnet. Indeed, there is very little difference, in effect, between a coil of that size, and a mere flat spiral placed once round the magnet. The important point is to cover the pole of the magnet. Every succeeding turn adds resistance, without increasing materially the loudness of sound. I varied the power and size of the magnet by varying the power and size of the voltaic battery employed to magnetise it, and found that very little effect was produced by diminishing the power of the battery. In fact, the effect of articulate speech was produced from the receiving instrument when the battery was entirely removed from the circuit. In that case the only source of power would be the residual magnetism of the iron bar, and that showed that the only use of the battery could be to magnetise the iron bar; so, in subsequent forms, I dispensed entirely with the voltaic battery, and used a straight bar of iron magnetised steel. Increasing the size of the iron plate attached to the membrane, a very large increase in the loudness of the sound resulted, until finally I had a plate of iron almost as large as the membrane itself. By this, dispensing with the membrane altogether, perfect articulation was, for the first time, obtained, and in this form, which differs very immaterially from the present form, you have a plate of iron vibrated by the voice, in front of a permanent magnet with a coil of wire around it.

On varying the size and thickness of the permanent magnet, it is found that wonderfully little difference is produced by magnets of very different force, and on varying the size, diameter, and thickness of the iron plate wonderfully little difference is produced. The chief difference is a peculiar effect on the quality of the voice. I have produced distinct articulations from iron plates all the way from 1 in. in diameter up to 2 ft., and from $\frac{1}{64}$ in. to $\frac{3}{8}$ in. in thickness. In fact, if you take an ordinary Morse sounder, and use that as a receiving instrument, using a battery current to magnetise it, if you place the armature of the Morse sounder close against your ear, articulate sounds are produced from it. This shows very distinctly that the effect is probably molecular rather than anything else, and the vibration of the plate as a whole mars the effect. One of my best forms of instrument was constructed on this model, but I had the cavity completely filled with a pad, to prevent the vibration of the plate as a whole, and it articulated beautifully. When the pad was taken out, a peculiar effect accompanied the articulation —a drum-like effect, due probably to the vibration of the plate as a whole. In fact, I can describe very distinctly the effect produced by varying the size of the plate. Suppose we keep the plate of uniform thickness, and vary the diameter, commencing

with a small plate, we have articulation perfectly distinct, but it sounds as if you were speaking with a cold in your head; a purely nasal quality accompanies the sound. Now, keep the thickness uniform, but enlarge the diameter, and as you do so the nasal effect wears away, until, with a certain diameter, you obtain a very good quality of voice. Keep on enlarging it, and a coarse, hollow, drum-like effect is produced, and when you have it very large it sounds as if you had your head inside a barrel—a kind of reverberating sound. So keeping the diameter of the plate uniform and varying the thickness, commencing with a very thin plate, you will have the same drum-like effect. Now, as you gradually thicken the plate, you have the effect disappearing. Then you get articulation, and as you go on increasing the thickness you have that peculiar nasal quality produced, so that it is probable that the fundamental pitch of the plate itself has a great deal to do with the agreeableness or disagreeableness of the electrical articulation, but the size or thickness does not seem to impair the distinctness of the articulation itself. You see there is a peculiar form of mouthpiece for concentrating the air on the plate. I made one experiment of rather a striking nature, viz., I omitted entirely the cavity in the mouthpiece. The iron plate was glued solidly at every point against a block of wood, and I talked against the surface of the block, so that there was an inch of wood between my mouth and the iron plate. Yet I was able to carry on a conversation with a man three miles away. I will now show you the last form of apparatus, and it differs very little from the previous one. [Professor Bell here explained in detail, by the aid of the illustrations, the form of instrument.]

The effect of reversing an undulatory current is to strengthen and weaken the magnet, and the result is that the plate is attracted in a varying manner, and the plate at the receiving end vibrates in a similar manner to the one at the transmitting end, and so a similar sound is produced. You, therefore. have the voice of the speaker converted into electricity here, and at the other end of the circuit you have the current of electricity re-converted into sound. No voltaic battery is used in this form—nothing but the magnet itself. I may here state one defect of this current. I have stated that I have not yet discovered the means of producing a strictly undulatory current. It frequently happens that, for practical purposes, the current is sufficiently undulatory to produce, at the other end, the effect of articulate speech, but the current produced in the coil is not strictly proportional to the velocity of the motion of the plate, as was pointed out to me by my friend Professor Cross, of the Institute of Technology at Boston, for there is another effect produced depending on the proximity of the iron plate to the pole of the magnet. If it be moved with a certain velocity, and the plate is very near the pole of the magnet, the effect produced would be very much greater than if it were farther away; so that you have the approximation or the separation of the two affecting the result. In fact, when the plate vibrates towards the pole, the current produced is too strong, and when it goes from the pole of the magnet it is too weak, so that the effect is not strictly an undulatory current. If the amplitude of the vibration of the plate is very great the defect is magnified, but if it is lessened the effect more nearly approximates to the undulatory character. Hence the curious effect, that soft speaking is much more distinct than loud speaking. If you shout or roar into the telephone, you have the sound produced at the other end very londly; but a discriminating ear will recognise that the articulation is not so distinct as when you speak more softly into the instrument. However, theory shows one way in which the defect can be remedied. Suppose we have alternate impulses going along the wire, and that, when the plate comes towards the magnet, we have a positive current produced, and when it goes away, a negative current. The coil may be so arranged that, when the positive current traverses it, the magnet will be strengthened, and it will then attract the plate with greater force; and thus, when the first plate approaches the magnet, the other will do the same, and thus the defect will be magnified. But we may also arrange the coil so that, when the first plate approaches the magnet, the other will recede from it, and thus the effect I have spoken of will be neutralised.

This leads me to a very curious point in the use of the telephone, viz., that you can control the phase of a vibration by specially arranging the coil. You can take two telephones and arrange them so that, while some person makes a musical tone into the receiving instrument, the phases of vibration of the plates shall be identical or opposed. Sir William Thomson, a few days ago, made an experiment of this kind with me in Glasgow, and we found that the telephone is a beautiful instrument for illustrating the interference of sound. If you arrange the instruments so that you have the phase of vibration the same, and then place your ear to the instrument, you can perceive the sound approximately doubled in intensity; but arrange them so that the phases are opposite, and there is a "dead spot,"—silence is produced at one point. I never heard interference of sound so beautifully illustrated as in that experiment, and there is no doubt that many uses can be made of the instrument in acoustics, from the fact of our being able to control precisely the relative phases of two vibrating bodies. The experiments made with this telephone a few days ago by Sir W. Thomson have demonstrated the fact of an interference in the perception of sound. For instance, take two instruments, one vibrating in a certain phase, and the other in a phase nearly, but not quite, the same. Place one to one ear, you perceive the sound on that ear alone. Place the other to the other ear and you perceive it on that ear alone. Place them to both ears at once, and you can arrange the phases of vibration so as to make both tympanic membranes act at the same time, or vibrate in a different manner; and there is a curious difference in the perception of the sound. It cannot be described, but it is something of this kind. You place the instrument to each ear in that way; where the phases are identical, you have a single sound, and you may localise the sound say on the surface of the two ears, but when the phases of the vibrating plates are reversed, the locality of the perception seems to change, and it seems as if you heard the sound at the back of the head, instead of

at the surface of the ear. Moreover, if you take two distinct circuits, and have one telephone on one circuit, and one on the other, and have a musical tone produced from one telephone, which is almost, but not quite, in unison with that produced from the other, you have beats.

We know that if two organ-pipes, for instance, were vibrating in this room, the pitches of which were adjusted in that way, we should be cognisant of beats, illustrating the interference of sounds of that sort. Sir William Thomson writes me that he has shown that the same effect is produced in the sensation of sound, for, placing one plate to one ear and the other plate to the other ear, so that each ear perceived only one sound, the same effect of beats was produced, showing very conclusively the interference in the sensation of sound itself.

The next illustration shows the way in which the telephone can be employed for the actual purpose of conversing at a distance. It is preferable to employ for this purpose two telephones, one in front of the mouth, and the other at the ear, for it has been found that when one telephone alone is employed, it constantly happens that persons separated by miles of distance speak at the same time or listen at the same time, and by placing one telephone to the ear and the other to the mouth, conversation at once becomes practicable.

Of course the question will naturally arise how far can it be possible to use the instruments? That as yet we do not know. The limit has not been found. In laboratory experiments no difficulty has been found in using an apparatus of this construction through a circuit equivalent to 6,000 miles. In this instrument we have a powerful compound permanent magnet. The longest actual wire I have been able to experiment upon has been 258 miles in length, and no difficulty was experienced so long as the other parallel wires were not in operation. The instrument is wonderfully sensitive to inductive influences, and when you use a wire upon the poles with other wires you have the benefit of the other messages that are passing along the other wires on the telephone. However, means have been discovered very recently by which the inductive influence of other wires can be overcome and neutralised, so that I hope we may have the instrument in use upon circuits of all lengths. I do not know that there are any other points that I should like to mention to you to-night, excepting a new application that is shown here to a diving apparatus. Inside the diver's helmet you place a telephone of convenient structure, and in the place of using a separate telegraph wire, we use the wire that is coiled up inside the breathing pipe. In every breathing pipe of course there must be a coil of wire, in order to withstand the pressure of the water, and that wire we find can be used for the purposes of the telephone, so that the wire inside this pipe is connected with the telephone inside the diver's helmet, and the earth connection is simply made by attaching the other wire to the helmet itself which is in contact, outside, with the salt water. I had the pleasure of trying to converse with a diver yesterday, with perfect success, at Messrs. Siebe and Gorman's, in a tank. He heard every word I said, and I was able to understand every word he said; and when I told him to come up, by word of mouth, he obeyed me. I do not know that there are any other points of interest to you, but I shall be very happy to attempt to answer any questions that may be put.

DISCUSSION.

Mr. S. Ford asked what was the difference between this form of telephone and that shown at the Queen's Theatre some time ago by Mr. Varley; also whether the time was increased before the sound was received according to the length of the wire.

Professor A. G. Bell said the telephone of Mr. Varley was similar to his only in name. There was no similarity whatever between the ingenious apparatus devised by that gentleman for producing musical tones, by the action of intermittent currents of electricity and pulsatory currents, and his own apparatus for producing the *timbre* of a sound by utilising undulatory currents of electricity. There had been numbers of telephones brought before the notice of the public, but all previous telephones had consisted merely of methods for producing musical tones, and he believed his was the first which had been constructed in which the *timbre* of the sound was copied. In reference to the other point, he might state that no difference had been observed in the time required for transmitting sound. In conversing with his friend, Mr. Watson, when he was in New York and the latter in Boston, he put questions to him through the telephone, and instantly the answer came back as though they were in the same room, instead of being separated by 258 miles of actual distance. The speed was the speed of electricity, not the speed of mechanical vibration.

Mr. J. Scott Russell, F.R.S., said he did not rise to put any questions, but to express what he felt sure was the feeling of many present of extreme gratitude to the lecturer. There was probably no one who felt that debt more deeply than he did. The paper had taught some doctrines wonderfully wider and grander than even the interesting doctrines of the telephone, and taught them that the electric wave which went through the conducting wire was a wave, as was well said, not of mechanical force, but a wave of ethereal force, meaning the impalpable atmosphere through which the waves or electric force were transmitted at present by electric cables from England to America, and this same electric, atomic, or ethereal force was propagated at a uniform velocity, whatever was its nature, through a given wire or channel. But if, instead of this electric wire, he were to take a great channel of water 100 miles long, and then to take, instead of the plate of iron, or drum, a large plate of iron moved by a mechanical force—much like that which moved the drum of the ear—the force which he put into one end of the water channel would carry to the end of the 100 miles an exact copy and measure of the force which he had put into it at this end. This existed in air, in water, in electricity, and in ether, and it was one and the same law which governed all The same propagation through the same ether brought the rays of the sun's light from the sun to the earth, and the same carrier wave brought from the other side of the globe, from the oceans there, which were disturbed by the attraction of the sun and moon, those waves all round the coasts which were called tides. All these phenomena, from the tides and the wind to the rays of light and to the sounds of the telephone, were the motion of one simple phenomenon, the carrier wave, the wave of translation. In conclusion, he begged to move a hearty vote of thanks to Professor Bell.

The Chairman said that at this late hour he would not detain the meeting with more than a very few words. It was evident to all that they were witnessing the beginning of an invention destined to produce enormous benefits in our social condition. In one sense it was an infant invention, but in another it was evident that it had made great steps towards maturity. It was a principle in the progress of inventions that the first attempts at producing any great result were far more complicated than the form ultimately adopted; the progress of modern invention essentially consisted of simplification. This had been illustrated in this lecture, the first instrument described being extremely complicated. Professor Bell was aware that he had a complicated effect to produce, and could not suppose at first that it was producible by very simple means; but having gone through the process of simplification to a great extent, there was no doubt the invention had gone a long way towards maturity. It seemed as if the only thing left to be done was to increase the intensity of the effects, so that a whole room should be able to listen to the sounds produced, then, for instance, those who could not get in to-night might have assembled in a room over the way and heard the lecture. If they thought of the beginnings of the discoveries on which electric telegraphy depended in other branches, such as the discovery of the motion of the needle, or Faraday's discovery of induced currents, it seemed extremely probable that the exertions of Professor Bell and others who might take up the work would result in increasing very greatly the effects which they had perceived to-night, even if there was not much room left for further simplification in the means. Mr. Scott Russell had already expressed the general feeling of thanks to Professor Bell, and he would only put the resolution.

The resolution was carried unanimously.

At the conclusion of the meeting, some experiments were made with telephones which had been fixed in the room for the purpose, and connected with instruments outside. Of these, one instrument was fixed in the Council-room; one in the Adelphi Hotel, on the other side of John-street; and one at the office of the Society's printer, in Gough-square, Fleet-street. In this last case, an ordinary Post-office wire was used, and it was found that, though the sounds caused by induction were plainly audible, yet, at that hour of the evening, the neighbouring wires were sufficiently free to allow conversation to be easily and distinctly carried on. The experiment had previously been tried in the morning, but then the neighbouring wires being busy, it was only with great difficulty that any words could be distinguished. The length of this wire is just over a mile. On the shorter wires, of course, conversation was perfectly easy. Two new applications of the telephone was also shown, one for use in mines and the other for application to a diver's helmet. In the former, the telephone was made to repeat the sound produced by a piece of spring vibrated at every tenth revolution of an anemometer by suitable mechanism, and situated in close proximity to the pole of a magnet, beside which it vibrates without even actually touching it. A coil surrounding this magnet is joined up in the usual way to wires leading to the telephone, and it is found that every "tick" of the steel spring is heard in the telephone. This is the joint invention of Mr. A. Le Neve Foster, of the Silvertown Telegraph Company, and Mr. H. Hall, one of H.M.'s Inspectors of Mines. The telephone for use by divers is referred to in Prof. Bell's paper above. The instruments shown were all constructed by the Silvertown Telegraph Company, who have the contract for making Professor Bell's telephones in this country. As at present arranged, the telephones are arranged at the ends of the circuit in pairs, one being used for speaking and one for hearing. A pair of telephones are mounted on a convenient desk or stand, to which also is fitted a call-bell, and a battery or magneto-electric arrangement for calling the other end. The telephone or the alarm is thrown in and out of circuit as required, by a switch, operated by hand, or automatically by the rest in which the telephone is supported when out of use.

MISCELLANEOUS.

AMERICAN PATENT-OFFICE MODELS.

The recent fire in the United States Patent-office destroyed about 136,000 old models, 49,000 of which belonged to rejected cases. The loss is of no great importance, as, at the present rate in which models are being sent to the Patent-office—some 20,000 a year—but a short time will elapse before the places of those burned will be supplied. In one respect, the conflagration may lead to a good result, as it makes an excellent opportunity for Congress to amend the Patent-laws by dispensing with the present system of official examination, and also with the requirement of models. The latter chiefly benefit the Patent-office examiners, and that in no wise materially or indispensably. On the other hand, they are a source of expense to inventors, often largely augmenting the cost of a patent, and increasing the hardships of those who have already resorted to self-denying expedients to raise the funds to pay the regular fees. In this case, to abolish models would tend to stimulate invention.

When our Patent-laws were enacted in 1790, the model was a useful provision. Knowledge of the art of drawing was not widespread, and the number of devices patented so small—the total number of patents in 1791 was 33, and in 1792, 11—that perhaps the best way to make the invention known was to produce it in miniature and display it in the capital city of the country. But now, when not only the number of patented devices has so enormously increased, but also the means of spreading information concerning them in almost like proportion, when the inventor can obtain at a moderate cost accurate drawings and exact descriptions of his device, or can himself easily acquire the requisite draughting skill, the model plays little part in conveying the idea to others. Photography, unimagined when the Patent-laws were framed, now admits of the production of the most minute and perfect representation of inventions; and by the various processes of photo-engraving, &c., drawings and plans can be multiplied indefinitely.

Models, as records, but poorly fulfil their purpose. They occupy large spaces, necessitate especial care for their preservation, and, as the past fire shows, furnish an enormous mass of dry painted and varnished combustible matter, which burns like tinder. There is more sentiment than sense in the oft-repeated assertion that they constitute a great national museum, wherein the rise and progress of American invention can be studied. As for any one overhauling the chaos on the Patent-office shelves, examining even each specimen of a class, and discovering in each the peculiar advance which it may shadow forth, it is simply a physical impossibility. Long rows of models look impressive, and the average visitor is quite willing to let his imagination have free rein as to their signification; but the best that can be truly said of them is, that while some are intrinsically interesting as historical relics, the majority constitute a monument showing only in the aggregate how prolific is the genius of the American inventor. In Europe, where a patent system has existed for nearly three centuries, and in other countries, models are not generally required, and the necessity for them has not been found to exist.

In brief, they have come to bear the same relation to our patents as does the pound or so of yellow wax which

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,307. Vol. XXVI.

FRIDAY, DECEMBER 7, 1877.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

PROFESSOR BELL ON THE TELEPHONE.

In consequence of the large number of members who were unable to obtain admission when Prof. Bell read his paper on "The Telephone," the Council have specially requested that gentleman to repeat his discourse, and he has most kindly consented to gratify the members by so doing, on Wednesday, the 19th inst. As there is certain to be a large attendance, it is suggested that those members who were present at the meeting of the 28th ult., should refrain from exercising their privilege of attending on the second occasion.

SILVERSMITHS' WORK.

The Council offer the sum of £100 (placed at their disposal by Messrs. Watherston and Son), together with the Society's medal, for the best essay on "The Art of the Silversmith, past and present, of all nations, with practical suggestions for its future developement."

The essay must be historical as well as practical, and should point out the *chefs d'œuvre* produced in various countries.

It is necessary that the obstacles which have tended to retard the progress of the art in England should be set forth, with a view to their removal, and that suggestions should be made for improvements in the various branches of the art. The names of the judges will be published hereafter.

The premium will not be awarded unless an essay of sufficient merit be submitted.

THIRD ORDINARY MEETING.

Wednesday, December 5th, 1877; Sir CHARLES REED, Chairman of the London School Board, in the chair.

The following candidates were proposed for election as members of the Society:—

Brown, John, Claremont-villa, Falcon-road, Battersea, S.W.
De Roux, William, Consul for Portugal and Brazil, Panama.
Laing, Robert James, The Limes, Upper Clapton, E.
Leary, Thomas George, 48, Avondale-square, Old Kent-road, S.E.
Mayers, William Henry, Clevedon-lodge, Thurlow-park-road, West Dulwich, S.E.
Salkeld, Lieut.-Col. Joseph Carleton, 29, St. James's-street, S.W.
Sennett, Alfred Richard, 109, Clapham-road, S.W.

The following candidates were balloted for and duly elected members of the Society:—

Allen, Samuel, Canal-road, Mile-end, E.
Andrews, William Ward, 238, Kingsland-road, E.
Aumonier, F., 110, High-street, Manchester-square, W.
Bache, Alfred, 10, Victoria-chambers, Victoria-street, S.W.
Barker, John, 252, Cornwall-road, Notting-hill, W.
Barratt, Samuel, 55, Wood-street, E.C.
Bayliss, John, 5, Victoria-street, Westminster, S.W., and Surbiton, Surrey.
Bishop, William, 174 and 176, St. John-street, E.C.
Bosanquet, William David, St. Stephen's Club, Westminster, S.W.
Boyd, John Frederick, 68, Upper Thames-street, E.C.
Broadberry, William Henry H., The Gas Works, Tottenham.
Buckler, John Russell, The Lower Gannicox, Stroud, Gloucestershire,
Carlisle, Henry, The Eastern Telegraph Company, Bombay.
Carpenter, H. S., F.C.S., Palace Chambers, St. Stephens, Westminster, S.W., and The Firs, near Alton, Hants.
Conrad, Julius, 13, Pembridge-gardens, W.
Curtis, C. H. O., 3, Crawshay-road, North Brixton, S.W.
Dangerfield, William, 59, Bartholomew-road, N.W.
Davidson, Alexander, M.A., Addison-lodge, Ridgway, Wimbledon.
De Carvalho, Joseph Brant, C.E., care of F. Youle, 155, Fenchurch-street, E.C.
De Cornelissen, Louis, 22, Great Queen-street, W.C.
Dick, G. Alexander, 110, Cannon-street, E.C.
Drew, Joseph, M.B., 4, Foxgrove-road, Beckenham, Kent.
Duckham, Heber, Millwall, E.
Dutch, Louis L., M.A., 97, Lower Mount-street, Dublin.
Fenwick, Mrs. Elizabeth H., Chapel Allerton, near Leeds.
Field, Walter, The Pryors, Hampstead, N.W.
Finn, Alexander, British Embassy, Teheran.
Forsyth, Sir Thomas Douglas, 76, Onslow-square, S.W.
Gainsford, Thomas Robert, Whiteley-wood-hall, near Sheffield.
Gandon, Charles, Crystal Palace District Gas Company, Lower Sydenham.
Glendinning, Andrew, 76, Chancery-lane, W.C.
Goffin, Robert Edwin H., F.C.S., Alexandra-street, Victoria-street, Westminster, S.W.
Gough, Ralph D., Willenhall, near Wolverhampton.
Guest, Sir Ivor Bertie, Bart., Muckross Abbey, Killarney.
Hall, Charles Edward, 22, Grove-terrace, Leeds.
Harper, Thomas Henry, the Phœnix Works, near Redditch.
Harris, Henry, M.D., Trengmeath, Redruth, Cornwall.
Herington, William Henry, 1, Halbrake-terrace, Wandsworth, S.W.
Horn, T. S., 60, Hawkesley-road, Stoke Newington, N.
Houghton, Francis Evelyn, C.E., Crossness, Erith, Kent.
Hudson, William, 43, Moorgate-street, E.C.
Key, John Thomas, Bromsgrove.
Knight, James, Portway-house, Weston, Bath.
Knowles, Thomas Foster, 48, Moorgate-street, E.C.

Le Maitre, Charles Edward, 8, Ramle-terrace, Egremont, Cheshire.
Leslie, Joseph Blackburn, Sheffield.
Lindley, William, Frankfort-on-Maine.
Martin, John Henry, York-chambers, Adelphi, W.C.
Martin, W. H., 11, Markham-square, King's-road, S.W.
Maude, Frederick, Royal Mews, Buckingham Palace, S.W.
Meredith, Alfred John Rouse, Durham-villa, Wandsworth-common, S.W.
O'Donoghue, William Power, Ph.D., 11, Peter-place, Adelaide-road, Dublin.
Ormiston, Thomas, C.E., Ormidale, West Dulwich, S.E.
Osler, A. Follett, South Bank, Edgbaston, Birmingham.
Pare, Cornelius Benjamin, 30, Finsbury-square, E.C.
Patterson, John, 9, Inverness-terrace, Kensington-gardens, W.
Peak, Henry, 3, Market-street, Guildford.
Perkins, Loftus, Seaford-street, Regent-square, W.C.
Phillips, William, The Lancrets, Luton, Bedfordshire.
Proctor, Richard Anthony, 2, North-road, Clapham-park, S.W.
Reynolds, Alfred, 112, Jamaica-road, Bermondsey, S.E.
Robinson, S. H., Calcutta.
Sanders, John, Belmont, Selhurst-road, South Norwood, S.E.
Smith, Frederick Charles, M.D., 21, Gower-street, Bedford-square, W.C.
Thomas, Charles, 2, Great St. Helen's, E.C., and Clarendon-house, Buckhurst-hill, E.
Thornely, Edward, West Brow, Arkwright-road, Hampstead, N.W.
Thornely, William, Reform Club, S.W., and West Brow, Arkwright-road, Hampstead, N.W.
Vyse, Griffin William, F.R.G.S, F.G.S., &c., 21, Stanley-gardens, Kensington-park, W.
Walker, Major-General George Warren, R.E., 1, Marlborough-buildings, Bath.
Walker, James Alexander, C.E., 14, Queen Victoria-street, E.C.
Wallis, Charles James, 11, Montpelier-row, Blackheath, S.E.
Warren, John V., 4, Beresford-place, Dublin.
Willson, Alfred Rivers, Ph.D., 368, Clapham-road, S.W.
Wright, Miss Christian E. Guthrie, 6, Lynedoch-place, Edinburgh.
Wrigley, William Sanders, 71, Tredegar-road, Bow, E.

Corresponding Member.

Orovio, His Excellency Don Manuel, Marquis de, Minister of Finance of Spain, Madrid.

The Secretary read the following letter from Sir Henry Cole, K.C.B :—

Manchester, 3rd December, 1877.

Sir,—Distance, work at Manchester, and age combined, will, I fear, render it impossible for me to be present at the reading of Mr. MacCarthy's paper on Wednesday. I request you to express my regret to the Chairman, Sir Charles Reed, to whom elementary education owes so much, as well as to the Rev. Mr. MacCarthy, an active and zealous member of the Birmingham School Board, who will certainly impress the meeting with a sense of his practical knowledge of the working of the present Education Code and its imperfections.

Had I been present, I should have tried to show that this country, compared with Germany, Holland, &c., in elementary education, is only at the beginning of the work. Much has been done; but much more of a practical kind has yet to be done. Above all, it is necessary to admit that the present Code can only be accepted as rules to be improved with the growing intelligence of the public of education, and to be altered if necessary with every Session of Paliament.—I am, Sir, your obedient servant, Henry Cole.

To the Secretary of the Society of Arts.

The paper read was—

CERTAIN WEAK POINTS OF THE ELEMENTARY EDUCATION CODE.

By the Rev. E. F. M. MacCarthy, M.A.,
Member of the Birmingham School Board.

"Unheralded by any flourish of trumpets, the Education Department, last Session of Parliament, in a modest way introduced a measure into the Revised Code of Education of high national importance, which is destined to have a great influence on the future development of national education, more or less affecting all classes of the people."

The words I have just read are not my own; they are the words of the leading journal, and the measure to which reference is thus made is the introduction of "Domestic Economy" into the curriculum of our public elementary schools.

The truth and wisdom of this utterance, and the foresight of the writer who penned it, were destined to speedy illustration. Domestic economy had scarcely been twelve months installed in its position in the Code, when its high national importance was abundantly testified, first, by the resolution passed by the Council of the Society of Arts as to the desirability of holding a Congress of educationists, to be devoted to the discussion of this subject; and then by the fact that the Congress so held was one of the most influentially attended, the most likely to bear practical good fruits, of any Congress that has been held in the country for some time past.

And no less abundant is the testimony to the soundness of the *Times'* prognostications as to the great influence which the introduction of domestic economy into the Code is destined to have on the future development of national education. The strong *consensus* of opinion which Sir Henry Cole carried along with him at the Congress, as with earnest persistency he argued for making domestic economy the chief practical art upon which the elementary arts of reading, writing, and arithmetic should be exercised, must convince all those who still need convincing, that the influence of this subject upon the principles and practice of national education is destined to be great indeed. At present, the subject introduced by Lord Sandon, as the *Times* says, in "a modest way," occupies a retiring and humble position, suited to the modesty of its ushering in; it is to be found in the last column of a remote schedule, and at nearly the last page of the Code of Regulations, and it is labelled "For Girls;" much like the notice-board at a watering-place, which points to that part of the foreshore set apart for the bathing of girls, and which warns off rude and prying boys.

But what the Congress meant, if it meant anything at all, was this: We believe in domestic economy, and want to see it to the front, to the fore-front, boldly and widely applied to the educational needs of the whole wage-earning class; and if Lord Sandon, when he introduced it thus "modestly" into the Code, meant it to to stay there, in virgin coldness, unproductive, then we mean something very different from Lord Sandon, and hope to convince him and convert him. The voice of the Congress was as the voice of the poet—

"Come down, O maid, from yonder mountain height,
For love is of the valley, come thou down."

We want domestic economy, not for the few hardy climbers to the height of Standard VI., but for the teeming multitude of untrained intelligences in the valleys of the lower standards, boys as well as girls, who have to face the world with what little stock of economic and other education we can give them in the few years between infancy and the summons to labour. And it is because of this belief and this desire that the *Times*' view of the future of domestic economy, as an educational engine, is that which holds with sanguine educationists, rather than the view of its destiny which its present position in the Code would warrant us in holding.

It will now be clearly seen how a Congress which began by discussing domestic economy, ended by discussing the Revised Code. The terms of the indictment were formulated by the Birmingham Local Committee, at a meeting held on October 8th, under the title of "Notes on the Congress," and these "Notes" are the brief to which I am to speak to-night.

The attempt to place domestic economy in its proper place in the Code—*i.e.*, in such an advantageous position, as regards examination and grants, that it would soon take its proper place in education—had the effect of bringing out into stronger relief than ever certain weak points in the Code's regulations and working. For this reason, I prefer to make my observations perfectly general, leaving you to gather, from time to time, their bearing upon the subject in which you, as members of the Society of Arts, are more particularly interested.

Though the Revised Code dates only from 1862, there is abundant evidence that its author did not foresee the enormous changes which, only eight years afterwards, the Education Act of 1870 would produce in the aspect and condition of the great national education problem. So little did coming events cast their shadows before, on to the mind of Mr. Lowe, that, in the same memorable speech in which he introduced the Revised Code to the House, he was heard to declare that "compulsory education was out of the question in this country." And, though a good deal has been done since to modify the Code in points of detail, and to make some much desired extensions, very little has been done to alter or modify the main principles upon which it was based. The time has now come to reconsider those principles in the light of the altered conditions with which we are surrounded. What these are we may gather by stating that, previous to 1870, no grants were given to any schools unconnected with religious denominations; no grants were given for any scholars who were not of the weekly wage-earning class; no machinery existed for the universal provision of sufficient school accommodation; no laws provided for the universal presence of efficient schools, while compulsion, and bye-laws fixing a standard of education as a qualification for employment, were declared to be "out of the question in the country."

Now, what modification in the Code corresponding in magnitude to these changed conditions has taken place?

(1.) The number of attendances qualifying for presentation for examination has been increased.

(2.) The examination of scholars by classes, in contradistinction to individual examination, has been in part re-introduced.

(3.) The number of subjects which may be taught has been enlarged or more clearly defined.

This is all. Various other changes, relating to amount of grant to be earned, the mode of staffing a school, the payment for pupil teachers, &c., have taken place, but I am simply considering the Code in so far as it regulates the inspection of schools, the examination of scholars, and the system by which grants may be earned upon resnlts.

It will be as well to give here an outline of the present mode by which these results are ascertained, and the grant awarded in due proportion to them.

Examination.—Scholars above seven are examined individually in three subjects, reading, writing (including spelling), arithmetic, provided they have attended during the year 250 times out of a possible 440 or 450. All but the lowest standard in the school may (the option lies with the managers) be examined by classes in two out of four subjects, viz., grammar, history, geography, needlework. The higher standards may also take up for examination certain specific subjects, of which ten are enumerated in the Code.

The grant is earned in three or four different ways:—

1. On average attendance of scholars.
2. On individual passes in the three R's.
3. On the class subjects, provided half the number examined pass a satisfactory examination in two of those subjects.
4. On individual passes in specific subjects.

Inspection.—There are at this moment upwards of 120 H.M. inspectors and 100 assistant inspectors. The inspectors are, almost without exception, University men; the assistant inspectors are ex-elementary teachers, picked men from the body of certificated and trained schoolmasters. The inspectors are required to examine in all the subjects set down in the Code as permissible in public elementary schools. These subjects at the present time are:—Reading, writing (including spelling), arithmetic, English grammar, geography, history, needlework, English literature, mathematics, Latin, French, German, mechanics, animal physiology, physical geography, botany, domestic economy, practical cookery, singing, military drill, and drawing. H.M. inspectors are considered to be qualified by previous education to test results, and to criticise and advise on the methods of teaching employed in all these subjects, *except one.* There is one exception which the wise forbearance of the Committee of Council on Education has permitted to be made to this tax upon their omniscience, and that is in favour of Drawing. I suppose the Department's personal experience of the bad handwriting of most University men made it obtrusively obvious that this, at any rate, must be excluded from the range of which inspectors must take cognisance. Drawing is accordingly relegated to the Science and Art Department. But, seriously, if drawing, why not also botany and animal physiology? On what principle of natural or unnatural selection has it come to pass that, of three or four subjects coming under the domain of the Science and Art Department, one only—and that one, Drawing—is referred for

examination to that body, and the others left to the inspectors. Many of us in this room to-night know personally an inspector or two—the Chairman of this evening must know many of them—is it our experience that the inspectors we know have, as a matter of fact, any greater acquaintance with animal physiology or botany than they have with drawing? And arguing from the known to the unknown, may we not fairly conclude that the general body of inspectors is as ignorant of these subjects as our personal acquaintances are? And what shall we say of needlework? Are the facilities for the study of this subject at the Universities so great—so much greater than for the study of botany, for instance—that we may fairly assume that though an inspector's botany may be doubtful, his "needlework" at least is sound—that here, if anywhere, he is equal to the occasion, and will be a most efficient judge of the minute intricacies of Lord Sandon's new needlework schedule? And if we have any doubt on this matter, who shall solve the difficulty? Botany and animal physiology are taken up by few. But needlework must be taken up by every scholar in a girls' school, or grant will be withheld; and, in addition, the class grant depends upon the performance of needlework carefully graduated by standards.

The theory of course is that, practically, a University man, like an Eton boy, is equal to any occasion, and that the mental training that is implied by a public school and University education, gives a man such an "all-roundness" that there is nothing that he cannot do the moment he puts his hand to it. Of course practical schoolmasters know differently to this, and so do the inspectors themselves. Take Mr. Steele, Blue-book, 1876-7, p. 571, who says:—

"Only a few have presented "specific subjects" (Schedule 4) under Art. 21. As time goes on there will probably be more. The specific subjects which have been presented are physical geography, literature, mathematics, domestic economy, animal physiology, Latin, French, and botany. I need hardly observe that omniscience is one of the most indispensable qualifications of her Majesty's Inspector of Schools."

The thinly disguised irony of this remark tells its own tale, and we can see that Mr. Steele looks with no slight apprehensions, on personal grounds, at the probable increase in the already wide range of subjects. German and mechanics, the two remaining subjects in this schedule, will be the last straw that breaks the camel's back.

To come to the point, this is how matters at present stand. The Science and Art Department —which is only, bear in mind, another Department of the same Committee of Council on Education—undertakes the examination of scholars in public elementary schools in drawing, and, in certain exceptional cases (see Science Directory, section 51), in any other of the 24 subjects named in the Science Directory. Now among these subjects are the following, which are also to be found in Schedule IV. of the Code, and so are ordinarily examined in by inspectors of schools:—Mathematics, mechanics, animal physiology, elementary botany, physical geography.

In the name of economy and efficiency, I say relieve her Majesty's Inspectors of the tax upon their omniscience to this extent, at least, and have the mechanical part of the examination in these subjects performed by the existing machinery in the Science and Art Department. The subjoined clause of the "Notes on the Congress" meets this point:—

"10 (*b*). That the subjects, such as botany, physiology, &c., already undertaken by the Science and Art Department, should be examined in only by that department."

Other parts of an inspector's work, of which I would, as a matter of course, relieve him on grounds of expediency and efficiency, are—

1. *The Sanitary Inspection of School Premises.*—This should be dealt with, as proposed in section 23 of the "Notes on the Congress," by the local Medical Officers of Health.

2. *Needlework.*—The Congress on Domestic Economy established so conclusively the absurd position of the inspector in relation to this subject that it will be only necessary to refer the unconverted to the published report of the Congress, and to clinch the matter by quoting the words of Mr. Matthew Arnold in this year's Blue-book, p. 400:—"No one will seriously maintain that a set of men are the fit judges either of the plans on which to teach needlework, or of results of examination in it."

3. *Practical Cookery, and portions of Domestic Economy, applying to Clothing and Household Matters.*—These should be eliminated from an inspector's range of subjects on precisely similar grounds.

4. *Singing and Military Drill.*—Common sense seems to suggest that examination in these subjects can only be efficiently undertaken by experts.

Clauses 12-14, 20-23 of the "Notes on the Congress" contain the suggestions which are made to remedy the defects that have been pointed out.

"12. That needlework should be tested by work done in the presence of superintending authorities, and sent up from each school to qualified examiners.

"13. That examination in the practice of cookery should be conducted by qualified official examiners, who should visit local centres annually for that purpose.

"14. That singing should be tested by results ascertained by qualified official examiners, who should visit schools or local centres annually for that purpose.

"20. That women should be eligible for appointment as inspectors.

"21. That women should be appointed as examiners in needlework, clothing, household matters, &c.

"22. That military officers, non-commissioned officers, or pensioners should inspect military drill.

"23. That the medical officers of health, already appointed throughout the country, might be employed, with efficiency and economy, in reporting upon the fitness of the school buildings, their ventilation, heating, sanitary arrangements, &c."

The inspectors of cookery and singing would, of course, take much larger districts than the present inspectorial districts.

Having thus eliminated from the range of subjects now falling to her Majesty's Inspectors those which we consider they are unable efficiently to deal with, let us see what remains—reading, writing, arithmetic, English grammar, geography, history, English literature, Latin, French, German. No one will doubt that it would be always easy to find inspectors fully qualified to undertake these subjects. But the question which I now wish to urge upon your consideration is whether some change—some radical change—in the present mode of inspection and examination of these sub-

jects, is not called for as a matter of expediency. The present mode is briefly this. On a day of which notice has been given, the inspector arrives at a school, bringing with him, in many cases, an assistant inspector. The examination is partly oral, partly on slates (for Standard I., and sometimes Standard II.), and partly on paper. The principal part of the paper work consists of dictation and arithmetic. The arithmetic questions have to be framed by the inspector beforehand, and sent up to the Department to be printed. The dictation and arithmetic papers are taken home and looked over by the inspector and his assistant. Now it is obvious that, as the inspector does not examine the schools in his district collectively or simultaneously, but consecutively, he must frame as many different sets of arithmetic questions in each standard as he has schools in his district, and he must, in addition, have fresh sets of questions every year for several years before he could venture to use again old sets of papers in his district. If he were not to take this precaution, his questions would, by being passed on from school to school, become known in the district, and his examination would become a farce. This is what each inspector has to do. Now, as there were last year 83 inspectors in charge of districts, and there will soon be 90, we have to multiply the labour ninetyfold, in order to get at the true estimate of its amount. And, in the same proportion as the waste of power in this method, is the waste of taxpayers' money in the printing of these innumerable different sets of questions. But there is another point. You are aware that one great object of this individual examination in the several subjects, reading, writing, and arithmetic, introduced by the Revised Code in 1862, was that the country might know that it was not paying away money without a definite and tangible result in the shape of so many scholars yearly who had attained definite standards of proficiency on these subjects. When, then, it is told that 15,000 odd scholars passed Standard VI. in arithmetic in 1876, it imagines that there is one standard (numbered VI. in the range of standards) representing a fixed and definite amount of proficiency in that subject. But it is not so; there are 90 Standard VI.'s—as many, in fact, as there are inspectors. We know the Department does what it can to keep the standards of its several inspectors up to the typical standards traditional at head quarters, but this must be more or less of a failure in practice. The difference between the "personal equations" of 90 inspectors, *i.e.*, the difference in amount of deviation from the typical standard which their questions would show, must be very considerable. Then, again, the country cannot be at all sure that, under present arrangements, the tender-heartedness of an inspector may not lead him insensibly to slightly dilute the dose in certain cases, to adapt it to the more delicate constitution of some feeble school which had other claims upon his forbearance. In short, the present system is wasteful of the mental powers and time of the inspectors, wasteful of the taxpayers' money, and is fatal to that uniformity of standards throughout the country which lies at the very root of the principle of payment by results on individual examination.

These conclusions had formulated themselves in my mind when I alighted on the following remarkable confirmation of my views in the report of Mr. Steele, inspector for the Preston District, in this year's Blue-book (1876-7), p. 586:—

"There seems reason to suspect that the setting of arithmetical problems has increased among teachers the very questionable practice of endeavouring to obtain copies of the sums given in other schools. Not that I would accuse every teacher who seeks to know the sort of examination another school has had of a dishonest intention. It is natural, and it is customary with all teachers of all ranks, to ascertain the style and standard of the questions likely to be put to their pupils. But I wish to say distinctly, that if a teacher goes beyond obtaining a general outline for his guidance; if, for example, having got possession of the questions set in another school, he practises his scholars in them, with the hope that the same may be given in his own examination, he is guilty of a fraudulent design; and if his design succeeds, he is obtaining money and credit on false pretences. I am glad to observe that this practice has been noticed, though not as yet so decidedly as I hope it will be, at a meeting of the Preston Teachers' Association. Teachers, if they combine at all, should certainly combine in discountenancing what is disgraceful to their own body and unworthy of their profession.

"It might, however, be well to take additional precautions. At present, each inspector has his own arithmetic questions, which are printed for him by the Department. The preparation of these questions is a matter of some labour, and since it is necessary to change them frequently, they are soon obsolete and useless. I wish myself that these questions could be changed more frequently than they are; and I venture to suggest that the Department might issue monthly to each inspector as many sets of arithmetic papers as he would be likely to want. At the end of the month they might be returned to be used again elsewhere. The questions in use in the various districts would, when revised and reprinted, form an immense stock to begin with. The advantage of this would be—(1.) Economy in preparation and in printing; (2.) Uniformity of standard throughout the country; (3.) Reduction of the possibility of obtaining questions beforehand to a minimum."

It seems, then, that Mr. Steele's experience furnishes one more reason for a change in the present plan, viz., that it is desirable to reduce the temptation to obtain a sight of the questions beforehand to a minimum. This is an additional argument, and one of very great weight, considering that the temptations to petty fraud, which the Code affords in one way or another, are, as I shall have occasion to show further on, almost enough to corrupt a saint. Mr. Steele's scheme of reform is, that the Department shall issue monthly to each inspector as many sets of arithmetic questions as he would be likely to want. The principle is the right one, only it requires a wider application; as he puts it, it would only, on his own showing, reduce the possibility of petty dishonesty to a minimum, but what we ought to try to do is to take away the possibility altogether, and that end will, I believe, be secured, together with the other ends at which we are aiming, by the following plan:—Let *all* that part of the individual examination of scholars which can be conducted by written papers, whether pass subjects or specific subjects, be carried out by special examiners at head-quarters. Let the necessary examination questions be framed by these examiners, and the written work of the scholars be sent up to the

Education Department, to be looked over by sub-examiners under the direction of the special examiner in each subject. In other words, extend to all the written paper work, the principle which is already in operation in public elementary schools in the case of drawing, and which is partially in operation with reference to the annual examinations of pupil teachers, the principle which has been adopted with such great success throughout the country by the Science and Art Department. And if, in addition to this, it were possible to take another leaf out of that Department's book of operations, and arrange that all the schools whose school-year ends at the same time could be examined in the same subjects in all parts of the country simultaneously, an enormous additional gain in economy of time, labour, and money would undoubtedly ensue. I believe this is quite possible. The Science and Art Department have their inspectors of drawing schools, but the superintendence of their examinations is conducted by persons of such standing and position in their respective localities as to place them above suspicion. If the Committee of Council can secure such important voluntary assistance from the general public, on the ground of the intrinsic merit of one branch of technical education, I make no doubt whatever that the same public spirit would be elicited in answer to the Committee of Council's application for similar assistance in conducting its examinations of scholars in subjects of general elementary education.

And this leads me to my next point. I dare say the thought has occurred to you that, by my scheme, the inspector has been elbowed out of his position of examiner, and little or nothing is left him to do. Very far from it. Everything has been left him which an inspector ought to do when he visits a school, and he has only been relieved of mechanical work—work which is distasteful to him, which he has very largely given up doing, but has handed over to his assistant. The Rev. H. G. Alington, in this year's Blue-book, p. 388, speaking of his assistant, says:—"The examination of children in classes, and the ordinary inspection, now occupy so much of my time that I have been obliged to hand over the standard examinations almost entirely to him." In fact, the inspectors have felt the drudgery of the Revised Code most acutely, and have hailed the assistants as the greatest boon. The Rev. C. H. Parez writes:—"Nothing could exceed the dulness of her Majesty's Inspector's life in school during the past five years. The human interest had almost vanished; everything but reading and recitation being done on paper or slates, intercourse between inspector and children is reduced to a minimum, and her Majesty's Inspector felt himself to have little more than a mechanical index of proficiency in the three R's. But happier times have come, and the children can really see that we are living human beings and not mere automata." Mr. Parez does not mean that the mechanical index of proficiency in the three R's is done away with, and class-examination put in its place, for the two kinds of examination exist side by side; but that, as he has got to do class-examination, the "mechanical-indexing" falls to the lot of the assistant the Department have given him. There are still "automata," but he, thank heavens, is not one of them. So that, it seems, we are not touching the inspector's real work, but simply the work of the "automata." Now, these "automata" are costly, they are picked certificated masters, attached by ones and twos to each inspector's district. There are some 100 of them, and their travelling expenses alone must amount to something in the course of the year. Why not save this at least, and probably reduce their numbers, by having these "automata" stationed at head quarters in London as assistant examiners, to look over these examination papers as they come in from all parts of the country? The saving in time, labour, and cost would be considerable.

On the other hand, let the inspector make a "real visit of inspection" to every school in his district, quite apart from the visit when the individual examination is going on, which latter, for distinction sake, I will call the "visit of examination." At this visit, let him satisfy himself as to the condition of the registers, log-book, &c. In order to avoid a recurrence of those vague and unsatisfactory stock-phrases, of the days before the Revised Code, such "impalpable essences," as Mr. Lowe called them, as "moral atmosphere," "general impression, "tone on the whole," &c,, let the efficiency of the individual members of the staff be tested as to their power of maintaining discipline, and their modes of organisation, as well as with reference to their several capacities as teachers. "Such visits would be of especial use," says Mr. Parez, "in schools whose teachers are untrained, and have little power of organisation." Let this be carried out according to a definite plan laid down by the Department, who would furnish each inspector with formal instructions, and questions on these matters, requiring categorical answers. Lastly, let him have the classes up before him one after the other, and examine them himself, in those elementary subjects which may have been agreed upon as subjects of class-examination. What those subjects should be is a matter for future discussion. I see no reason whatever why they should be confined to grammar, history, and geography. There should be no undue official restraints in the selection.

But you will say, this is the old much-abused Code come back again. In principle, no doubt, it is only the old Code brought back again, with the knowledge of the dangers to be guarded against, and with every ability to avoid those dangers. The principle of the old Code was "Inspection," the principle of the Revised Code is "Examination." It is now high time that the two principles, between which there is no real antagonism, should be yoked together. Things have been tending in this direction for some time past. The "Class Examination," introduced a year or two ago, for which a grant of 4s. per scholar may be earned, has restored the kind of examination which was characteristic of the old Code. The "visit without notice," when it is used as something more than a visit of surprise to detect irregularities in registration, affords the inspector who so uses it, an admirable opportunity of doing much that comes within the range of our ideal "visit of inspection."

At present, inspectors avail themselves of this privilege of making visits without notice to very different extents. There were (in 1876) two dis-

tricts in England where as many as 100 days were spent by the inspectors in visits without notice; next come six districts with days so spent ranging from 33 to 50. The total number of inspectorial districts is 83, and the average number of days spent in visits without notice in the remaining 75 districts was only nine. Now, the fact that the inspectors of the districts of Liverpool and Birmingham spend 100 days in "visits without notice" speaks volumes for the advantages which, to their minds, the plan of visiting a school at another time to that when the individual examinations are going on, possesses. At present, the Department seems scarcely consistent. If these visits without notice are not what, evidently, the inspectors of the Liverpool and Birmingham districts consider them to be, viz., of the utmost importance, why has the Department so strengthened the inspectorial staff of these districts as to make 100 days of visits without notice possible? On the other hand, if these visits are of such importance that the Department is willing to incur the expense necessary for thoroughly carrying the plan out in two districts, why has it not made arrangements by which these visits shall be the rule throughout the country, and not the exception?

Now, if those schools whose school year ends in a given month, were examined in standards and specific subjects *simultaneously* throughout the country, as has been suggested, at the beginning of the month, or in batches spreading over the first fortnight; and if the papers of these scholars were all sent up to London to be looked over, her Majesty's Inspectors would then have the last fortnight of each month, or half the whole available time (220 days), for visits of inspection. Inspectors might even take larger districts than they do at present, thereby reducing the ever-increasing expenditure for additions to the inspectorial staff.

I am well aware that Mr. Lowe had the alternative of half inspection and half examination before him when he introduced the Revised Code, and that he rejected it in his celebrated speech in the House of Commons, February 14th, 1862, with the following observation:—"Suppose half the grants were earned by inspection, and half by examination, then schools would earn half the grant without any exertion, and a certain part of the other half without exertion; so that a school would teach nothing, and yet get on very comfortably." Under any circumstances I do not think any fear need be entertained that such a thing could happen in 1877. But though I would have some of the grant follow the report of the visit of inspection, I am not prepared to recommend that it should bear so high a proportion to the whole as a half. We can quite understand the necessity Mr. Lowe was under, in 1862, of putting his foot down firmly against any half and half measures. As the *Times* said on that occasion:—"A gigantic system, the mushroom growth of a night, had arisen among us; none cared to touch it, till the rapid strides of its expenditure, the huge multiplicity of its agencies, the growing deficiency of results, absolutely compelled interference with a strong, if not a rude hand." But we have got over our scare. The old Code had its good points; we can now look back upon the controversy without passion, and adopt these good points which we could ill afford to lose, while carefully shunning the bad.

There is another argument for a modification of the system of inspection in this direction, from the fact that many of the results of sound methods of instruction, some of them of more lasting benefit than those rewarded by money payments, elude altogether the present mechanical examination process of the inspectors. The efforts that may be made to cultivate the intelligence of the scholars, and to strengthen their powers of observation, reflection, and comparison, meet with scant recognition or reward from the present Code. Little or no encouragement is held out to managers of schools to employ teachers of high mental calibre, and mature in age and attainments, instead of young, ignorant, and uncultivated pupil-teachers.

Mr. Duport, in this year's Blue-book, gives some interesting statistics of comparison between town and country schools, and his figures show the following remarkable fact, that "country children, though trained in schools nearly 25 per cent. below town schools in general efficiency, can yet equal the town schools in their individual passes in examination." Could anything be more discouraging to the efforts made for efficiency by the School Boards in our large towns than such a fact as this? It is time that "efficiency" was paid for as a result—as the most valuable of results—and it becomes the duty of everyone who cares for real education to press for such a reform in the present system of examination as will give to the general intelligence among the scholars, due to high-class teaching-power, ample recognition and reward. The plan I propose would certainly effect this.

The following clauses, 7-10, 15-17, of the "Notes on the Congress," embody in set terms the suggestions I have been making:

"7. That for promoting greater efficiency and economy in public elementary education the mode of inspection and examination should be reorganised, and a clear division made between the personal inspection and the individual examination of the scholars of a school.

"8. That her Majesty's Inspector's annual visit to a school should have for its object inquiring (according to instructions formally laid down and published) into the discipline (including gymnastic drill, not military, which should be specially examined), organisation, the general efficiency of the class teaching, and the teaching power of the staff.

"9. That the individual examination of the scholars should be independent of this official visit of the inspector, and should be carried out, as far as practicable, by written papers, under regulations such as those adopted by the Science and Art Department for the examinaeion of drawing in public elementary schools.

"10. That writing from dictation and arithmetic by the scholars in Standard II.* and upwards, and all the optional subjects, should be tested by results sent up from each school, and referred to special examiners, on the same principle as the examinations are conducted by the Science and Art Department.

"15. That for simplifying the machinery for conducting the examinations referred to above, all schools should, as far as practicable, be examined in the same subjects, in all parts of the country, simultaneously.

"16. That the inspector, his assistants, or other competent recognised authorities, should superintend

* A higher standard than this might be adopted at first, until the new machinery at head quarters had got into thorough working order.

the examination by papers, examine in reading, read the passages for dictation, and see that the regulations for the conduct of the examination are being strictly carried out.

"17. That the written report of the inspector's official visit should be forwarded to the Education Department, to be considered in conjunction with the examiners' reports on results, and upon both of these grants should be earned by a school."

I now come to the last point upon which I wish to dwell, and it is by no means the least important. You are doubtless aware that the great bulk of the examination grant is earned on the individual passes in reading, writing, and arithmetic, not of all the scholars in the school, but of those who have made 250 attendances, out of a possible 440 or 450, at that school during the year. I am now going to urge the total abolition of this restriction on the number who can be presented for examination; and I do so on the following grounds. Whatever fairly plausible reasons for the restriction may have existed previous to the Education Acts (such as to prevent a good school from farming out its good scholars to earn grant for its shaky neighbours, or to make the interest of the managers in the regular attendance of their scholars as great as possible), these have now, at all events, lost their force. School Boards and school attendance committees have relieved managers and teachers of very much of their anxieties about attendance. The work is done for them to a very great extent. And there is not the least danger of managers and teachers losing their interest in the regular attendance of their scholars. Irregulars are not good grant-earners, and never will be. Then the "child's school book" will be before the inspector, and, with this great safeguard, he can make it impossible for a fraud to be committed upon the Government. If that book shows that a scholar has passed Standard II. in his last school, then he must be presented in his present school in Standard III.; and, if he can pass the examination in that standard, though he has been only a week in the school, why, in the name of education, should he not be allowed to do so? What the country wants is, results. What the country is prepared to pay for is, results. Why thwart it in its humour? But this is exactly what the Code regulation does, for it says, we won't pay for *all* the results, but only for those obtained by scholars who have made 250 attendances during the year in the particular school under inspection. Now I am quite certain the country does not realise this. When, for instance, it is told that 800,000 odd scholars passed in standards in arithmetic, it believes that that is the whole number in the schools capable of achieving these standards of proficiency; but this is a delusion. The number is probably a good deal greater. It is calculated that an intelligent scholar can frequently get through a standard in half a year, or in 225 attendances, if he is properly taught by an efficient staff. Many of those, then, who have made between 225 and 250 attendances would pass if they were not excluded from the examination. Then, again, children whose parents have moved, and who send them to a new school which happens to be within 25 weeks of its inspection, are also excluded by this regulation. Look, too, at the grave injustice to these children. As they are not presented at that inspection in a certain standard which they could well pass, there is nothing to prevent their being retained in that standard all through another year, doing identically the same work, instead of being carried on to the work of a standard higher,

Then, there is something extremely anomalous in the present regulations in this matter. A scholar cannot be presented for individual examination in reading, writing, and arithmetic, unless he has made 250 attendances in that school, but he must be presented for class-examination in grammar and geography, however irregular he may have been, if his name has been six months on the register. Now, it is obvious that, if he has been irregular, the effect will show itself mostly in the weakness of his grammar and geography; he might pass in the three R's, he certainly would not pass in the class-subjects. So the Department has committed itself to this, an irregular scholar shall not be presented for examination in the three R's, in which he might, by chance, be able to pass; but shall be presented in grammar and geography, in which he is morally certain not to pass. But further, in the three R's examination, the scholar stands or falls by his own merits, if he earns a grant well and good; if not, the school is only a loser to the extent of his individual grant-earning power. But in the class-examination, the scholar, if he falls, brings others down with him—the grant is paid on the number of scholars in average attendance, but no grant is paid unless half of the scholars pass. As, then, he goes into examination morally certain not to pass, he is a dead weight on his class, so much so that he and one or two others like him have it in their power to turn the trembling scale on to the side of half failures, and thus deprive their school of the whole of the grant for class-examination.

It may be urged that this clause requiring 250 attendances acts beneficially in discouraging capricious removals from school to school. The teacher uses every effort to retain a scholar who has made his attendances and is likely to pass, and looks coldly on every new scholar, who is not able to make them. But he will use that effort just the same, without the existence of this limitation, and use it too over a wider area, because the total number of those who are likely to pass is greater than than the number who have made their attendances and are likely to pass. Then, again, supposing the scholar, in spite of cold looks, chooses to come—has no choice, perhaps—then the teacher, seeing that he is entirely valueless as a grant-earner this side inspection, neglects him altogether. Again, is it an altogether unheard of thing for a scholar who is not likely to pass to have little notice taken of his irregular attendance, lest he should make the attendances qualifying for presentation for examination, and lower the per-centage of passes.

It may also be urged that without some such limitation one school would reap the fruits of another's labour. If a child, having been three-quarters of a year in my school transfers himself to my neighbour's, and shortly afterwards passes in a given standard, the labour of preparing him for that standard has been almost all mine, and I ought to have a proportionate amount of grant. Very true, but surely there will be a good deal of "give and take" in this matter, and we must trust to the general working of that principle to equalise

our claims upon each other. *De minimis non curat lex*, in other words, the Department does not trouble itself about fractions of grants. That is the case now to a very large extent; a school that has had a child for the first 25 weeks or so, borrows him on the day of its inspection from the school where he has spent the remaining 20 weeks, and pockets all the grant which that child may earn.

A still greater hardship has now to be endured with equanimity, in the case where a child moves from one school to another under the same board of management, and has not quite made 250 attendances in either school. Though the particular School Board has borne all the cost of the child's education for the year, though the child has made as many as 200 attendances in each school, or 400 in all, and could pass the examination with ease, yet, as the regulations now stand, that child could not be presented for examination in either school, and consequently could earn no grant to relieve the ratepayers of the cost of his education. The abolition of the "250 attendances" restriction would remove this hardship.

But I come now to an argument against the "250 attendances," far weightier than any that I have at present advanced, weighty as these are. This regulation—this device of the Education Department—has a great deal to answer for. It has been the cause of the moral ruin of scores of elementary teachers. This is a grave charge, and I make it with every sense of its gravity. I would say with Mr. Rice-Wiggin, in this year's Blue-book, p. 545, "I am thankful to believe that in the great majority of cases the honour of the teachers is a sufficient guarantee for non-falsification of registers; but I fear that there are some even among this body who cannot at all be trusted; and, on account of these, everything which tends to diminish the temptation to, or increase the checks upon, false entries, becomes more valuable." Let us see what is going on. All grants (except the class grant) are dependent upon the number of attendances of the scholars of a school, these attendances are calculated from the school registers, and the registers are in the hands of the teachers; so that a dishonest teacher may add considerably to the grant of his school by tampering with the registers which are in his charge throughout the year. That there are teachers thus dishonest is only too apparent from the hints, and more than hints, of her Majesty's Inspectors in the last two or three Blue-books. In the Blue-book of this year, two pages and a half are filled with a list of teachers who have had their certificates cancelled or suspended, or their schools mulct in grant, mostly for faults of registration. One inspector gives in an appendix twelve glaring cases, which occurred in his own district. These I fear may be taken as types of many others. Very few inspectors, as we have seen, avail themselves to any great extent of the "visits without notice," and it is only at these visits, and not at the annual inspections, that the subtler kinds of fraud can be discovered, if they ever are discovered; of course, in a large number of cases, the inspector is only too glad to give the teachers the benefit of the doubt.

These remarks strike at all those grants which depend upon attendance, *i.e.*, at the grants which depend upon average attendance, as well as the grants to be earned in standards and in specific subjects, into which the condition of 250 attendances enters. But I wish to point clearly out that it is just where this condition enters that the temptation to dishonesty becomes so formidable.

The average attendance grant is 6s. per scholar, so that a teacher who receives a part of the grant as salary is interested to the extent of a fraction of 6s. in each unit in the number in average attendance. Now, as the school meets 450 times, or thereabouts, in the year, and as, by the rule of the Department, the total number of attendances made by all the scholars must be divided by this 450, it follows that a dishonest teacher must make 450 false entries in his registers to add one to the average attendance, and so benefit himself to the extent of 6s. But each scholar who has made 250 attendances can earn 9s. for passes, and 8s. in specific subjects, a total of 17s., and the teacher's interest is to the extent of a fraction of 17s. Suppose a scholar, whom the teacher knows to be able to pass, has made only 245 attendances; then, only five false entries, in the last week, of "present" instead of "absent," will make all the difference between a 17s. grant and none.

Now we all know that there are hundreds of people who would commit a petty fraud, for one who would be guilty of a great one. By a convenient confusion of thought, men measure the extent of the moral offence of a fraud by the extent of the means necessary to compass it. Is it not a little one? Just a stroke or two of the pen; just a little forgetfulness to call over the registers for a day or two, and then a filling-in, hap-hazard, from memory; this laxity here, and that irregularity there, began as pupil-teacher, continued with deadened conscience, till the barrier-line between carelessness and fraud is passed. Surely if the inventor of the "250 attendances" condition had been Mephistopheles himself, he could not have devised a more subtle means for sapping the moral integrity of a noble profession.

"Well," it may be said, "but is the abolition of the '250 attendances' the best remedy for the evil? Why not remove all temptation from the teachers, by paying fixed salaries?" Mr. Kennedy, in his general report in the Blue-book of 1875-6, in words which have been re-echoed by more than one inspector since, says:—"So many teachers are paid by receiving the whole or part of the annual grant which is awarded in proportion to the average attendance, and are also paid through the grant which may be obtained by scholars who can be shown to have attended 250 times, that such teachers are thus daily exposed to an immense temptation. I wish most heartily that this temptation to untruthfulness in the daily registers of attendance could be removed, either by the action of school managers in not making the salaries of teachers in any way dependent on children's attendance, or still more effectually, perhaps, by devising some other mode of awarding money to schools out of the Parliamentary grant." As I do not believe that you can possibly work a school without, in the long run, paying directly or indirectly by results, and as I believe that the grant earned must contribute to the teacher's salary or his reputation, or both, so I feel convinced that the teacher's interest in the grant must always be great. Many schools, too, cannot afford to pay

fixed salaries. My remedy is of a much simpler character, and it will prove an effectual remedy for evils we must all deplore. I recommend the total abolition of all regulations requiring a stated number of attendances on the part of scholars as the condition of their earning grant for examination. I am, therefore, prepared to advocate, in the terms of clause 19 of the "Notes on the Congress," with a slight modification, that, "as the clause requiring 250 attendances as a condition of presentation for examination (Code, Art. 19 B) acts prejudicially to education, it should be modified, with proper safeguards, so as to provide that *all* the scholars present on the day of examination shall be examined, and be eligible for earning grants for their school, on the understanding that the failure of those who have not been a given length of time under instruction, should not be statistically recorded against a school."

In conclusion, let me commend the questions I have raised to the thoughtful consideration of all who are interested in the development of a sound national system of education. There are many points, both of principle and detail, which I have been unable, from want of time, to touch upon. There is the question of pupil-teachers and the conditions of their apprenticeship, a question which is sufficiently important and complex to call for separate treatment and discussion. There are many questions of pure detail, apparently, which, however, are found to involve the tacit admission of principles to which objection may be taken. To give just one instance. The grant on class-examination, if the scholars pass in grammar and geography, is 4s. per scholar in average attendance, but this grant is reduced to 2s., if the number of scholars examined —not as you would suppose, in classes, in grammar and geography, but in the upper standards, and in totally different subjects, viz., reading, writing, and arithmetic—falls below a certain percentage of the total number examined. It is difficult to see the justice of this. If the class-examination grant is fairly earned on the subjects of class-examination, by all means let it be paid without deductions for weaknesses disclosed in quite another direction. If the standard work is weak, and a deduction seems warranted on that account, let the deduction be made on the grant for standard work; or, better still, if the Department wishes to encourage the presentation of scholars in the higher standards, let it give grants at a higher rate for passes in those standards. The present plan reminds me of one of my little girls, who said to the other, "If you don't lend me your pencil you shan't have any of my cake next birthday." The logic of the Department in this regulation seems equally undignified. Can you be surprised if schoolmasters, feeling the incongruity of this regulation, obey no more than the bare letter of it? The clause says that a certain per-centage must be presented in Standards IV. and upwards. Now, there is no difficulty about presenting scholars in any numbers in any standard. A master can present as many scholars in Standards IV. and upwards as Glendower could "call spirits from the vasty deep," but will they pass? that is the question you would think. Not so; the Department does not care about the passing, only about the presentation. And the schoolmaster, not seeing the force of being fined 2s. for every scholar in average attendance when he has fully earned it on class-examination, is quite ready to fall in with the humour of the Department. Only the other day, I was expressing some surprise that a schoolmaster, who was on the eve of his inspection, had succeeded in presenting the required per-centage, when he ingenuously replied "I am; a poor man I could not afford not to make my per-centage."

Amongst the most substantial of the benefits that have accrued to this country through the Education Act of 1870, must be placed the enlisting of men in every rank of life in this great work of national education—men of broad culture and sound judgment—men who have gained their experience in every kind of arena, in literature, science and art, as politicians, lawyers, magistrates, and schoolmasters, in the office, the manufactory, and the workshop. It is to these that we must look for a wise broadening of the lines upon which the machinery of our national system of education is based. The regulations of the Education Department, as now embodied in the Code, are some of them harassing, some meddlesome, some positively mischievous; they are cumbered in parts with the accretions of successive revisions, extending over upwards of thirty years, and the whole requires to be carefully reconsidered under the wider aspect which the problem of national education has assumed during the last few years.

DISCUSSION.

Mr. Hale was in favour of the 250 attendances, but he agreed that the duties of inspectors should be more circumscribed.

The Rev. J. P. Faunthorpe said the paper was most interesting and valuable, but there were a number of other matters which might well have been touched upon, as, for instance, the case of pupil-teachers; and he, for one, would have been glad if Mr. MacCarthy had dealt less with payments for attendances and some other matters, and said something on the question of pupil-teachers. If it was possible to remodel the new Code according to those notes drawn up after the Birmingham Congress, it would not be reformed but revolutionised, so that those connected with it in its present form would not know it again. Most of those particularly engaged in schools deprecated so continuous an interference with the arrangements. A picture had been drawn of the omniscience required of inspectors in examining in all these science subjects, but it was not so very terrible a matter when you remember that the boys and girls examined were but ten or twelve years of age, or fourteen at the highest, and that the amount of botany, physiology, or other sciences they learnt was obtained from small hand-books which the inspector could get up on his journey. Besides, he believed that all schools where sciences were taught to any serious extent were examined by the South Kensington Department. Needlework was much criticised when it was introduced; ladies who knew anything about the subject were perfectly astonished at the arrangements, and no doubt it did seem absurd for a man to examine in such a subject; but, on the other hand, he supposed they all knew something of needlework; and he knew one inspector who said that he had a universal test for it. He gave the seam a good tug, and if it stood the test he passed it as good needlework. If they were to have special examinations for needlework, military drill, cookery, botany,

physiology, and the other matters, the question arose when would they cease being specially examined? The difficulty he felt was that both the expense and trouble would be considerably increased; and there would, also, be an enormous increase of that centralisation against which they ought to protest, as there was already far too much of it. Mr. MacCarthy had pictured a genial inspector dealing kindly with one school and another according to its weaknesses, but all he would say was, he should like to see such an inspector. He might have a personal equation; but, when he came under the direction of the Lords of Council, he must put his personal equation in his pocket, and obey the printed instructions, or he would soon get into difficulties. He should like to say a word or two on a subject which had not been touched on in the paper, viz., the schedule for pupil-teachers; because, while complaints were made of children not knowing their subjects, it was necessary to know something about the teaching staff. He spoke more particularly of girls, because he was more familiar with that branch of education, and he must say that the schedule contained the most barren and unworthy syllabus ever drawn up. A girl might pass through the syllabus, and present herself at the training-college for simple elementary examination, and be absolutely plucked. During the present year about 2,000 went up, and some hundreds—he forgot the exact number—were rejected. Now, if you had teachers, at the end of five years' apprenticeship—during which period they had presumably been taught for an hour and a half a day, and examined year by year by qualified assistants—at the end of the time failing in their examinations, what sort of teaching could be expected to be given to the children at their hands? A great deal had been done, especially by the London School Board, and he trusted it would do still more, as its influence in the end would extend over all the schools of the country; but the syllabus needed to be made more definite, and to have subjects put into it which the pupils would like to take up. He entirely agreed with Mr. MacCarthy about the 250 attendances, and with his criticisms upon the reflection that it put temptation in the way of schoolmasters. The present Blue-book contained several pages with a list of 60 or 70 masters and mistresses who had lost their certificates merely on account of these attendances. If a master's salary were £60 a year, and half the grant, and a child made 245 attendances in the year, there was a strong temptation for the master to tamper with the register. No one knew why the exact number of 250 had been fixed upon, why it should not be 245 or any other number, but at present if a child had attended only 249 times he could not be presented or examined, although, perhaps, if this were done, he would pass well and earn a grant of from 10s. to £1. In that case the country would not be defrauded, since it paid for results, and why should not every child in the school be examined under some some such restriction as had been suggested, viz., that he had not passed the same standard during the year in another school. He made no reflection upon schoolmasters, who were a selected body of men, but if 68 of them yielded to temptation it was impossible to say that the temptation was not very great, and one which ought not to be put in their way.

Mr. Grove begged to congratulate Mr. MacCarthy on having hit very exactly the opinion of practical teachers with regard to the Revised Code, especially as it existed before the last two years; and he did not at all wonder at it, when he remembered the intimate relations existing between that gentleman and the teachers of Birmingham. He could not, however, endorse the whole of his statements, nor agree that his suggestions were the best possible. He should like to allude more particularly to the last point mentioned by the previous speaker, viz., the temptation to falsify the registers in order to make up the 250 attendances. The number originally fixed was 200; it was adopted in order to ensure regularity of attendance; and he must say from practical experience that it had that effect, for it did very good service, before they had the powerful aid of compulsion, which by the way was not so effective as some people thought, in obtaining regular attendance. But it certainly worked great injustice both to scholars and teachers. The latter went almost entirely with Mr. MacCarthy in advocating the entire abolition of this regulation, and there did not appear to be any reason, except a financial one, for retaining it. The only danger was, which he knew to be a real one, the same child being examined in two different schools in the same year.

Rev. Mr. MacCarthy—In the same standard?

Mr. Grove said he alluded to the time before the different standards were introduced. If the school year did not end at the same time, a boy might make the requisite number of attendances in two different years, and so be qualified for examination, and earn, as the Government thought at the time, a double grant. That was the reason why the number 250 was placed in the schedule. With regard to the remark that the suggested alteration would revolutionise the Code, he believed most of those practically concerned would be glad to see it revolutionised; what they objected to was its being constantly tinkered at, so that it required a good deal of study to understand it; in fact, he often received letters from teachers in different parts of the country, asking what was the meaning of it. He did not suppose that these suggestions, even in a modified form, would be adopted just yet, but if they were to have a change made once for all, the best way would be to see how it worked for five or six years, and then have the results of that experience embodied in a new code. That was the only way in which the best system of national education could ultimately be developed. Even Mr. MacCarthy, he thought, hardly realised the weakness of the Code with regard to the individual examination of the scholars, and the payment upon these individual examinations, as connected with the regulation requiring the 250 attendances. There could be no doubt that it placed a strong temptation in the way of schoolmasters, but he must protest most earnestly against the supposition that the elementary teachers of England were more susceptible than the generality of men and women to the influence of temptation. Mr. Faunthorpe had referred to a list of some sixty persons who had lost their certificates for this cause, but he ought to have added that these sixty were taken from a body of over 24,000 persons. As a body, they stood as high as any class in the community; in fact, he believed that even clergymen and lawyers more often made their appearance in the police-courts than did public elementary schoolmasters. The great grievance was this, that the payment was made on the examination of the child, but until within the last two years, whether the child passed or failed, he must go up in another grade next year. He was thankful to say that this had been now partially remedied; but only partially. He would go further than Mr. MacCarthy, and let the grant depend, not upon the individual examination of the children, but upon their average attainments coupled with the old kind of inspection, when the "moral atmosphere" was taken into account. You might pass a splendid examination in reading, writing, and arithmetic, without having the good, sound, moral atmosphere, which was after all of the greatest importance. That was one of the vices of the Revised Code, that it made no payment for the best results of education, and that was why it had been characterised by the best friends of education as one of the greatest blunders of late years.

Mr. G. Christian Mast thought the plan recommended in note 17, that the written report of the inspector's visit should be considered in conjunction with the examiners' reports on results, would be entirely

impracticable. He had spent the greater part of his life in teaching, and knew a good deal about examinations, and it appeared to him that the attempt to combine inspection with examination by written papers would utterly fail. It was extremely difficult to combine two modes of examination in one branch, and when the general examination was conducted by a central body in London, and by local inspectors in the schools, the difficulties would be so increased that he did not see how they could be got over.

Mr. Charles White asked if Mr. MacCarthy did not think the present Code too elaborate. Being on the committee of management of a Board school, he had some experience in the matter of drawing, and, from the wretched character of the results produced by some of the children, he was convinced that in many cases the teaching of this subject was merely a waste of time and money.

The Rev. E. F. MacCarthy said he was glad to find that, on the whole, the tone of the discussion was rather in favour of some revision of the Code. He would say first, very deliberately, what he had already said in his paper, that his sense of the honour and integrity of the great mass of elementary teachers was of the highest order, and he believed Mr. Grove was quite justified in saying that the code of honour was as high amongst them as in any profession in the country. What he said was that some of these provisions were enough to corrupt a saint, and he did not consider he had made any reflection on teachers, who were but flesh and blood like the rest of the world, in saying that the influence of the Code in this direction was so invidious as to sap the moral integrity of the weaker ones. It was quite true that his suggestion would revolutionise the Code, as far as the examination was concerned, but the effect upon the teaching in the schools would not be very great. It was something like special pleading to draw such a picture of the number of the special examinations as Mr. Faunthorpe had done, and speak as if it would be a great hardship on the scholars, because they would not be affected at all. It did not matter to the examinee who sent up papers in a dozen different subjects, whether they were examined by twelve special examiners or by one. As to the "personal equation," it was impossible for a man so to put that on one side as to alter the character of his handwriting, or the lineaments of his face. Then it was said that there were but few children examined in botany, and that they were under 12 years of age. He maintained that if there was only one to be examined, the duty of the examiner was as important as if there were 10,000; and with regard to the amount of science required, the principle enunciated by Mr. Faunthorpe was the origin of the whole mischief. He wanted to put a stop to examinations which could be conducted by a man who got up his subject during a journey from London to Canterbury. If ever they were to get real education, the examinations must be conducted by the best men, of the widest knowledge. Inspectors who had not only to examine the work, but to advise upon the mode of teaching, should be men who had made their subject the study of their lives. Mr. Grove had drawn attention to one point which he considered important, viz., that a child might have been examined in former days in two schools in the same year. Even now, he could be examined in two standards in two schools in a year if one school happened to have altered its time of inspection. But there was no hardship in that, provided he had gone through his standard in the year. The country did not want a mechanical process, by which children could only travel a minimum distance each year. They wanted results as rapid as possible, within the few years which a child could spare for school, and, therefore, public opinion was dead against those who said that a child should not pass in another standard in less than twelve months. If the school book showed that he was ripe for examination in Standard III, when he had passed in Standard II six months ago, the country would be ready to pay for it. He had alluded to the phrases "moral atmosphere," and so on, not as deprecating their use in the future in any degree, because he thought the moral tone of a school ought to be taken into account, but the real difficulty which led to the abolition of the old Code was that those phrases constantly occurred—depending very much on the digestion of the inspector and the sort of lunch he had had; and consequently the grant was distributed in a most promiscuous way, and no particular results were obtained. Mr. Lowe stated in the House of Commons that the result was that it was found you could get a moral tone, and you must pay for it; but as for getting reading and writing from the children of an agricultural labourer, it was impossible, that their fathers had not got it, and you could never get those results from children in agricultural districts. They could avoid the mischief of those vague phrases by giving the inspector certain definite instructions; as, for instance, to report how many adult teachers there were in the school, the lessons he heard them give, and on subjects, whether the result was good, bad, or indifferent, and so on. With regard to the gentleman who thought that inspection and examination were different processes, and would utterly fail in combination, he would say that this system was pursued now to a certain extent, because there were individual examinations upon the results of which the grants were paid; and there was also a class examination which was what he contended for only extended in scope and mode. He happened to be the master of a large school with 270 boys, and their annual examinations consisted both of inspection and of written papers. He sent up the mathematical, French, and German papers to examiners at Cambridge, Oxford, or London, as the case might be, who never saw the school, but in addition to that, four gentlemen came down and worried them for a week, and the prizes were awarded as the result of a combined process, which did not clash in any shape or form. He agreed with the last speaker that the Code was too elaborate, and the plan he proposed would simplify matters very considerably. There was no doubt that the tinkering which was constantly going on was the horror of schoolmasters; and it took place in consequence of the Code being a mass of accretion, which had grown up by degrees, and which had to be modified to meet the altered conditions which were constantly taking place, such as compulsion by School Boards, which was never dreamed of when it was drawn up. Let them make a clean sweep of the present Code, and have a new one thoroughly discussed in Parliament—in its broad principles at any rate. He had made a small contribution to this discussion, which he hoped would be carried on until they could settle down to some definite and satisfactory principles.

The Chairman said he could not agree that Mr. MacCarthy's contribution to this great question was rightly described as a small one, but he had himself confessed that he had only touched on some of the weak points, and others had been mentioned by some of the succeeding speakers. He should like, therefore, to challenge him to take an early opportunity of completing his paper, and dealing especially with the question of pupil-teachers. It was evidently one of the most important points to be brought before the teaching profession, and the public were also deeply interested in it. He concluded by moving a cordial vote of thanks to Mr. MacCarthy for his paper.

Mr. Faunthorpe seconded the motion, which was carried unanimously.

The Rev. E. F. MacCarthy said he was quite aware of the importance of the subject just mentioned by the Chairman, but it would require a separate paper to itself,

and he doubted if he were the right person to undertake it. He hoped, however, that some one would take it up who could thoroughly handle it from an independent point of view. It was an enormous advantage to education that there were so many gentlemen not officially connected with the Department—chairmen of School Boards and others, who became members of Parliament—who took an interest in the question, and to their fearlessness and independence of official leading strings, they must look for a real discussion of the merits of this question. Hitherto, it had been very much a question between the Department and the few chosen clergy whom they had chosen to take into their councils, but this state of things could not continue.

MISCELLANEOUS.

LIGHTNING CONDUCTORS.

The following appeared in the *Times* of Friday, the 23rd ult. :—

Sir,—Some inquiries were made last summer in the *Times*, in reference to the construction of lightning rods, and the learned societies were asked by your correspondents to furnish information on certain points concerned in this method of protection against accident. I should be glad, if you can allow me space, briefly to answer this appeal.

There is no doubt whatever that insulating supports are not required by lightning rods. When the earth connection of the lightning rod is of ample dimensions and complete, it is not of any practical moment whether the rod itself is attached to the building by metallic clamps or by earthenware supports. Even with an imperfect earth contact, the insulators ordinarily employed are of no use, because a high tension lightning discharge makes its way through such a puny obstacle as an inch or so of earthenware with the utmost facility. A moment's reflection will make this apparent, since it is no uncommon thing to hear of a lightning discharge leaping disruptively through a stone wall two yards in thickness as if it were merely a sheet of pasteboard interposed in its path. What is really required is that the discharge should be deprived of its high tension and be converted, as far as may be, into a gentle and continuous stream, which has no tendency to burst away from the conducting path. This is what is accomplished when a proper earth contact is provided for the rod; a spacious outlet for the escaping electric stream is in that way opened at the base. The most convenient and ready expedient by which this may be done is by packing about three bushels of coke closely round the lower termination of the rod, laid along in a trench cut into the ground to an extent of about 20 feet.

A copper band is assuredly a better lightning conductor than a twisted rope of copper wire of corresponding dimensions,* because the rope is liable to be molecularly strained in the process of manufacture, while the copper strap, or band, is actually improved for its work of electric conductor by the process of rolling which it has passed through. The size of the conductor is matter of more importance than is generally conceived, for two distinct reasons, which both require to be taken into account. In the first place, a $\frac{1}{2}$ in. rod of copper is certainly not a "sufficient protection in all circumstances." The resistance, and therefore the comparative inefficacy of a lightning rod, increases with its length as well as with its smallness. A rod which is employed to protect a building 160 ft. high requires to be as large again as the one that is used for a building 80ft. high and twice as large again for a building 240ft. high. A considerable proportion of the accidents from lightning in towns occur to very tall chimney stacks, most probably from this very cause. When the conducting rod of a tall chimney shaft is of insufficient dimension for its conducting work, there is always a ready temptation for the discharge to leap across the brickwork to the heated air and soot-covered surface within the shaft, which too often have a better communication with the earth than the outer rod. If my memory does not deceive me, there was one notable instance in the experience of Mr. Gray, the associate and successor of Sir William Snow Harris, in which a copper wire rope three-quarters of an inch in diameter proved insufficient for the protection of the lofty tower of St. Mary's Church at Taunton.

The copper tube which was so efficiently used by Sir William Snow Harris in his system of protecting ships was virtually a copper strip, or band, turned round upon itself into the form of the tube. The flat band has an advantage over the tube for land use, chiefly on account of its flexibility and ready adaptability to irregular surfaces, which it shares with rope; of the readiness with which it can be rolled to any required length, and can be made of any desired thickness and breadth; and of the facility with which it can be coiled for transport. The passage from the form of the tube to that of the strap, or band, was a natural transition. I believe that strap form of conductor has been employed by Mr. Gray, the successor of Sir W. Snow Harris, for a considerable time. It certainly, on the whole, constitutes the best kind of lightning rod that can be adopted; and great service has been rendered by the various manufacturers who have recently improved and simplified the process of manufacturing the copper tape in this flexible and convenient shape.

There is, however, another point of view in which the size of the lightning rod has to be contemplated, and this needs to be very carefully noticed, because it is so habitually overlooked in most references to the question. A lightning rod may be quite large enough not to be fused or destroyed by an electrical discharge, and yet to be so small that it very materially impedes the free flow of the electric force passing through it. The resistance offered by a conducting rod to the passage of a discharge of lightning is in proportion to the smallness of the rod. The smaller the rod the more leapingly and, so to speak, "disruptively," the discharge must make its way through the conducting mass. The smallness of the rod, therefore, favours the high-tension tendency of the discharge, or, in other words, gives it increased inclination to find a devious path by lateral and erratic outbursts, instead of following the course intentionally provided for it. For this reason it is well that the capacity of the rod should be made as large above the real standard size that is conceived to be sufficient to withstand the fusing power of lightning as circumstances allow. A lightning rod that would only just escape fusion and destruction from a discharge would certainly be a very insufficient protection against accident. The imperfect apprehension of this principle, again, is one which in all probability is not an unfrequent cause of mischief.

I am somewhat anxious here to say that I think the old dogma, that "a conductor does not attract electricity any more than an umbrella attracts rain," cannot now be received in an absolute and unqualified sense. A conductor in the near presence of a charged thundercloud becomes inductively excited, a very strong charge of the opposite kind of electricity to that in the cloud being drawn to the top of the rod. When this state of things has been brought about, there certainly is a stronger tendency for a spark or flash to pass across the intervening air-gap than there would be in the absence of any such inductive disturbance. The electricians who still hold this view would probably, nevertheless, hesitate to carry their argument home to its ultimate conclusion by saying that there is no attraction between the outer and inner coating of a charged Leyden jar immediately

* Dr. Mann has since written to the *Times*, to say that he finds it needful to modify this opinion.

before the electric forces shatter the glass to effect the discharge of the jar. It is, indeed, almost universally held that the charge of a Leyden jar is chiefly due to the attraction of the severed electric forces exerting themselves to unite through the insulating barrier of the glass. The charge in the outer coating of the jar comes up from the earth under what, in familiar terms, can hardly be called anything else but "the attraction" of the inner charge.

These several points which I have alluded to are all very important ones in their practical bearing, and in reality require that more should be said concerning them than could possibly be attempted in this place. The Meteorological Society, however, has a standing Lightning-rod Committee, which has been especially formed to deal with such questions, and to give the best information available in all that relates to the construction of lightning conductors to any one who may refer to them. They also particularly desire to have exact accounts of accidents from lightning furnished to them, as affording most valuable suggestions and assistance in some of the investigations in which they are engaged.

I am, Sir, very truly yours,
Robert James Mann, M.D., Vice-President of the Meteorological Society.

Meteorological Society, 30, Great George-street, Westminster.

ISTHMUS OF PANAMA CANAL.

Consul Mallet in his report upon the trade of Panama states that in 1875 the Government of the United States caused a survey of the isthmus for an inter-oceanic canal to be made by a party of American engineers, under the conduct of Commander Lull of the United States Navy. The course they took ran between Chagres and Panama, and for the greater portion of the route parallel and close to the railway. The total distance is about 49 miles, and the highest elevation above the level of the sea 170 feet, which attitude only extends over a very short distance, and would necessitate, therefore, the construction of only six locks. The surveyors expressed themselves well satisfied with the great facilities offered for constructing a canal by this route, and estimated the cost at 50,000,000 dols., or £10,000,000 sterling.

The Commission, however, appointed by President Grant at Washington, in the latter end of 1876, to examine into the various reports of the officers in charge of the different surveys, gave the preference to the Nicaragua route, which is 181 miles long, and runs through a country subject to violent volcanic disturbances. What the objections may be to the short route through the previously mentioned portion of the isthmus, where safe anchorage on both sides is found, are not clearly stated. The alleged greater unhealthiness of the isthmian route to that of Nicaragua, and the large sacrifice of human life which would be caused in consequence, in the construction of a canal from Panama to Chagres is, Mr. Mallet thinks, a fallacy. It has been asserted, and believed, that every sleeper laid down upon the Panama Railway line cost a human life, and the isthmus of Panama has obtained the name of being a pestilential locality in consequence; but this is far from the truth. Numbers of workmen did, no doubt, lose their lives during the making of the line, but it was chiefly the result of their own imprudence and unlimited indulgence in strong drink under a tropical sun. The route across the isthmus, surveyed by Commander Lull, would, it is said, not be less healthy than the coast portions of the Nicaragua route. The cutting of the Panama Railway across the isthmus, and the clearing of tracts of land along the line for grazing and cultivation, has had a marked effect upon the salubrity of the district through which it runs, and this change would, of course, act beneficially upon those employed in the cutting of a canal through that portion of the isthmus. The railway itself also would be of immense use in carrying out the work.

The chief difficulty to be overcome in the construction of a canal without locks, which, it is affirmed by some, could be cut from sea to sea, would be in preventing the immense body of water which overspreads the low land during the rainy season, and which rushes down the two rivers, Rio Grande and Chagres—the former into the Pacific at Panama, and the latter into the Carribbean Sea at Chagres—carrying down, with irresistible force, trunks of trees and other *débris*, from causing a similar result in the channel of the canal. This, it is believed, is the great objection which engineers make to a canal being formed in this region. Commander D. Ammen, of the United States Navy, in a paper prepared by him in 1876, at the request of the American Geographical Society, on the surveys and reconnaisances made in the American isthmus for a transcontinental ship canal, referring to the difference existing between the construction of a canal through the isthmus of Panama and that of Suez, says as follows:—

"The natural conditions of the American isthmus will be found widely different from those of Suez. One is a region of extraordinary rainfall, the other of an extreme dryness; the one covered with impenetrable and interminable forests, the other totally denuded; the one a region of steep escarpments and water sheds, where every ravine, many times during the year, becomes a river of rapid waters, rushing wildly to the sea and bearing huge masses of silt, giant boulders, and fallen trees, the other simply a sandy level plain. If the existence of any narrow American valley many miles in length between the seas be admitted, and a canal without locks be supposed to be located therein, it must become the ultimate drainage of that whole tropical valley. By what human power could it be kept clear of the *débris* swept into it by every heavy rainfall along its entire length?"

This, says Consul Mallet, may be true as far as "a narrow American valley" is concerned, but the country between Panama and Chagres is not a narrow valley, but a wide undulating country of hill and plain, with two good sized rivers acting as natural streams; but when it is considered of what an enormous advantage a through cut without locks, similar to the Suez Canal, would be, surely it would not be impossible in these days of advanced engineering science, either by culverts and embankments, or otherwise, to overcome such an obstacle. In the Nicaragua route it is proposed to overcome that difficulty by keeping the summit level of the canal at a permanent height of 108 feet above the level of the sea, which height is to be overcome by four dams and twenty lift locks. The summit level portion through the lake of Nicaragua, comprises fifty-six miles of the route, and sixty-three miles more, by slack water navigation; but then there are in addition sixty-one miles of canal to be constructed on the Atlantic and Pacific slopes, through a difficult, unhealthy, and volcanic country, in addition to the vast additional expense which would have to be incurred in making good harbours at Brito on the Pacific, and Greytown on the Atlantic side, at the latter of which ports the most violent tornadoes are constantly occurring.

Mr. Mallet therefore cannot understand how the American Commissioners have arrived at the conclusion that the Nicaragua is the best and cheapest route of any yet surveyed. The general impression at the locality itself, is that a far shorter route, and one easier to be constructed, can yet be found. At the present moment, a survey through a portion of the Darien is being made by a party of French engineers, across a route of alleged low elevation through a break in the Cordilleras, which it is asserted has been lately proved by some old documents found in the museum at Madrid to have been known to the Spaniards 200 years ago.

Mr. Mallet concludes by saying there can be no question that the time has arrived when an interoceanic ship canal through this continent is imperatively demanded

in the interests of commerce, in order to avoid the long, expensive, and dangerous voyage round the southern point of South America, and it would be well if the matter were more ventilated amongst European mercantile communities than it has yet been.

THE ECONOMIC USES OF FLOWERS.

Of the various parts of plants used industrially the flower would seem to be that of least importance, and yet this enters more than would be at first supposed into commerce, and many flowers are of the greatest importance to the perfumer and dyer. Not to speak of the trade in cut flowers and flowering plants, and the extensive commerce carried on in these in great cities, and passing over a considerable branch of trade in what are known here as "everlasting flowers" and "immortelles" on the Continent, an acre of which plants will yield two or three tons weight of tufts of flowers, realising from 12s. to 16s. per cwt.: a few details may be given serving to illustrate the commercial value and various uses of flowers.

Among the most important products in a commercial point of view are safflower, saffron, rose leaves, lavender, pyrethrum, orange blossoms, cassie flowers, violets, jasmine, tuberose and camomile flowers.

Safflower, from the deep orange petals of the *Carthamus tinctorius*, is obtained in parts of Southern Europe, India, and China, the latter being considered the best. The imports of safflower into this country vary considerably, having reached as much as 32,000 cwts. in some years, but in the last two years our supplies have dropped to about 3,000 cwts. The great centre for the use of this dyestuff appears to be Lyons, where it is employed to dye silks and satins.

We also import from 3,000 to 5,000 lbs. of extract of safflower, worth from £1,000 to £1,760. The exports of safflower from India exceed in value £100,000, and from China they are about the same amount, to say nothing of the local consumption is Asia and the produce in Southern Europe.

Saffron is obtained from many countries, but the preparation is chiefly confined to France and Spain. The total value of the saffron produced annually is estimated to amount to one million sterling. About 30,000 flowers are required to produce 2 lbs. of fresh pistils, which when dried are reduced to one-fifth of that weight. Pereira says it takes nine flowers to make up a grain of marketable saffron, so that it would require no less than 4,320 flowers to yield 1 oz. Some, again, assert that to produce 1 lb. of dry saffron 107,520 flowers are necessary, while others put the quantity as high as 203,920 flowers. According to Dumesnil, in the *Académie des Sciences*, 7,000 to 8,000 flowers are required for yielding 17½ ozs. of fresh saffron, and this weight, as already stated, is reduced one-fifth by drying.

Our imports of saffron are, compared with its use on the Continent, not very large. They were:—

	lbs.	£
In 1867	9,401	17,963
„ 1868	26,048	50,198
„ 1869	22,152	36,596
„ 1870	43,950	95,690

The imports into this country have not been published since then. The largest quantity comes from Egypt (nearly half), then follow the supplies of Spain and France, varying in quantity according to crop. Judging by prices, the Spanish would appear to be held in less estimation than formerly.

Very extensive rose farms exist at Shiraz, in Cashmere; at Ghazepore, in India; at Adrianople, in European Turkey; at Broussa and Uslak in Asiatic Turkey; and about Cairo and other parts of Egypt. It is said to have been the Princess Nour-Djihan who discovered, at the commencement of the sixteenth century, the essence of roses in the empire of the Mogul, and received for this a necklace worth £3,000. In 1611 the Sultan Ahmoud I. sprinkled the pavement and the interior of the new Kasbah with jets of rose water. It is also said that Saladin, after the Peace of Jerusalem in 1187, sprinkled the Mosque of Omar with rose water from Damascus. The odoriferous rose was formerly cultivated in the oasis of Fayoum, Middle Egypt, but the culture has been almost abandoned. The essence used locally there is now chiefly obtained from the ordinary roses of the country, collected in spring in the gardens.

Experience has shown that for every ounce of attar of roses 3,000 lbs. of rose leaves are required.

The yearly production of the districts in the province of Kezanlik is on an average 3,500 lbs. Some years, however, the bushes are exceptionally prolific. Thus in 1866, 6,000 lbs. were produced, but in 1872 only 1,700 lbs. could be obtained. The war now raging in this district has, however, made sad havoc with the rose gardens, and for a time destroyed the produce. The pure attar, at 30s. per ounce, yielded an income of £84,000 yearly to Roumania. Of rose leaves we imported—

	lbs.	£
In 1867	8,775	476
„ 1868	5,323	267
„ 1869	6,427	321
„ 1870	8,382	420

Since that year there has been no official return published.

The leaves are usually imported salted: 1 lb. of salt well mixed with one bushel of roses (6 lbs.) converts them into a magma (pickle). As their primitive odour is preserved they can be distilled at any time, and produce as good rose water as fresh roses. The Provence rose will yield in the second and third year from one to two hundred bushels of roses per acre. The damask rose is that chiefly cultivated for medicinal purposes. Just before the bud is about to open it is plucked, and the bottom of the bud is cut off. These cuttings are termed "rose heels;" the top is preserved either to make infusion of roses or conserve of roses.

M. Piver some time since published the following statistics of the flowers employed in perfumery annually produced in the department of the Alpes Maritimes:—

	Kilos.
Roses	904
Orange flowers	61,218
Jasmine	62,500
Tuberose	18,200
Cassie or Acacia	35
Violets	86

The yield of flowers per 1,000 metres (not quite a quarter of an acre) he gave as follows:—

	No. of Plants.	Flowers.
Roses	1,200	300
Oranges	25	250
Jasmine	3,500	130
Tuberose	17,500	500
Cassie or Acacia	750	750
Violets	—	200

The lavender fields in the London district cover about 500 acres, and the yield of essential oil varies from fifteen to thirty pounds weight per acre, according to the season or age of the plants.

The little bouquets of violets which are generally sold in the streets of London are the produce of many acres of land at Mitcham and its neighbourhood. On one farm there are 16 acres of land under violet culture. The two varieties of this flower principally grown are the Russian and the giant. The first-named is darker in colour; the latter is the most fragrant. There are large violet farms in the South of France, of more than 100 acres, near Nice.

Several species of *Pyrethrum* are grown in parts of Europe—*P. carneum*, *roseum*, &c.—for their flowers,

which are very obnoxious to insects, and are sold when powdered under the name of Persian or Caucasian insect powder. In 1870 these flowers were exported from Ragusa to the value of £1,104. That from the Caucasus is the best. The amount of this powder consumed annually in Russia is said to be about 500 tons. A quantity of these plants, grown upon 18 square rods, is estimated to furnish nearly one hundredweight of powder, which is best preserved in closed vessels of glass. As generally sold, the powder is very much adulterated and worthless, often mixed with sumach. A good insect powder ought to stupefy a fly in one minute if four grains are sprinkled on it in a vial, and death should ensue in two or three minutes. Some of the commercial insect powders, however, require fifteen to thirty minutes to kill a fly.

Incidental mention may now be made of some of the other uses of flowers at home and abroad.

The medicinal substance called semen-contra is obtained from plants belonging to the family of Composites: according to Batka it is yielded chiefly by *Artemesia Sieberi*, Besser. The flower-head is the part of the plant employed. Santonine, the active principle of the drug, is valued as a vermifuge.

In France the flowers of *Malva sylvestris* and *rotundifolia*, and of *Althœa officinalis*, *Nymphœa alba*, *Verbascum Thapsum*, *V. lanatum*, and *V. nigrum*, are officinal, emollient, and demulcent, furnishing a pure mucilage.

The marsh mallow is cultivated in certain districts of England, and held in repute as a medicinal plant, being used chiefly in fomentations and gargles.

The flowers of the well-known marigold (*Calendula officinalis*) were formerly used in soups and broths and as a carminative, but they are now chiefly employed to adulterate saffron.

The flowers of *Lyperia crocera*, of South Africa, resemble true saffron in smell and taste, and have similar properties: yielding a fine orange colour, they have been imported into this country for dyeing purposes. The flowers are in daily request with the Mohammedans at the Cape, who use them for the purpose of dyeing their handkerchiefs. They possess similar properties to saffron, and as an antispasmodic, anodyne and stimulant, according to Dr. Pappe (*Flora Capensis*) ought to rank with the *Crocus sativus*.

The flowers of the yellow ladies' bedstraw (*Galium verum*) have been used in England in the place of rennet to coagulate milk.

Saffron flowers and those of the Embuch are employed for dyeing in Turkey. Those of *Althœa filicifolia*, Cav., are used in Turkestan to form cataplasms for inflammatory swellings.

The extremely fragrant flower-heads of *Santolina fragrantissima*, Forsk., are sold in the shops of Cairo as a substitute for camomile, under the name of Babouny or Zeysoum.

An infusion of the dried blossoms of the common cowslip is drunk in some counties in England under the name of cowslip tea. The blossoms communicate an aromatic fragrance to home-made wines, resembling that of the muscatel wines of the south of France.

An infusion of the flowers of the lime (*Tilia europea*) separated from the bracts, is considered to be a sovereign remedy for headache in Switzerland and Germany. The flowers of the *T. argentea*, Desf., have been met with in Europe as a substitute for the flowers of *T. parviflora* and *T. grandifolia*, Ehrh. The flowers of the former species have larger bracts, which are of a greener colour than the officinal, finely reticulated above, and underneath densely covered with stellate hairs, which readily separate when dry, forming a woolly, irritating powder; the flowers have, particularly in the fresh state, an odour reminding of hyacinth and lily of the valley.

An infusion of the flowers of the linden is much used on the Continent, being considered good in vertigo and spasms, and against coughs, for its expectorant properties.

In North America *Calycanthus lœvigatus* and *C. floridus* are much prized for their highly-scented, inconspicuous flowers, which are often gathered and put into clothes drawers to impart their perfume.

Evodia hortensis is a favourite plant in the gardens of the natives of the Pacific Islands, being used for scenting cocoa-nut oil.

The small flowers of *Pandanus odoratissimus* are very fragrant, and from them an oil, known as keora oil, is obtained. The perfume is extracted chiefly from the male flowers. The floral leaves themselves are eaten either raw or boiled.

The flowers of a jasmine, the *Nyctanthes arbor tristis*, shed a delicious fragrance in gardens, where they bloom only during the night. It is at sunset they open, and before the morning the ground is covered with the fallen corollas. The native women collect them in India, and, stringing them on threads, wear them as necklaces, or twine them in their hair. The orange-coloured tubes dye a beautiful buff or orange colour, with the various shades between them, according to the proportion and mode of conducting the operation, but no way has yet been discovered of rendering the colour durable.

In the East the petals of the flowers of *Hibiscus rosa sinensis* are used for blacking shoes, and the women employ them to colour their hair and eyebrows black. They are also eaten by the natives as pickles. The flowers are used to tinge spirituous liquors, and the petals, when rubbed on paper, communicate a bluish purple tint, which forms an excellent substitute for litmus paper as a chemical test. In China they make these large handsome crimson, yellow, and white flowers into garlands and festoons on all occasions of festivity, and even for their sepulchral rites.

The flowers of *Acacia Farnesiana*, known as cassie, distilled, yield a delicious perfume. In Borneo the fragrant flowers of *Areca Catechu* are mixed with medicine for the cure of many diseases.

In China many odoriferous flowers are much used in scenting teas. Ball, in his work on "Tea," p.p. 162-164, gives a description of some. Among these the following may be enumerated:—The best kinds of Caper or Sonchy teas are said to be scented more or less with the curious green flowers of the Chu-Lan (*Chloranthus inconspieuus*, Swartz), although Fortune states that those of the *Aglaia odorata*, Lour., are used. These writers agree, however, in the following:—

Pac-sheen, the sweet-scented pale yellow flowers of *Gardenia florida*.

Quy-fa, or Kuey-Noa, the yellow flowers of *Olea fragrans*.

Moo-ly-Hoa, the white flowers of *Jasminum Sambac* and *J. paniculatum*.

For the cowslip-flavoured teas, the pink flowers of *Primula pœnitens* are employed. Orange blossoms and many other flowers are believed to be used, but they should always be full blown.

The *Mesua ferrea* is much cultivated in Java and Malabar for the beauty and fragrance of its large white flowers. When dry they are mixed with other aromatics, such as sandal-wood, and used for perfuming pomades. The blossoms are found in a dried state in the Indian bazaars, and are called Nagkushur; they are used medicinally, and much esteemed for their fragrance, on which latter account the Burmese grandees stuff their pillows with the dried anthers.

The large flowers of *Michelia Champaca* are celebrated for their exquisite perfume, and the tree is highly venerated by the Hindoos. The natives adorn their heads with them, the rich orange colour of the flowers contrasting with their dark black hair. Sir W. Jones states that their fragrance is so strong that bees will seldom, if ever, alight upon them.

Large numbers of the fleshy variegated calices of the *Hibiscus Sabdariffa* are dried and stored in parts of Africa; in this condition they retain their fragrance, and serve for the purpose of giving the soups of the

natives an acid flavour almost as sharp as vinegar. The calyx and capsule, freed from the seeds, make excellent tarts and jellies: a decoction of these, sweetened and fermented, is commonly called in the West Indies sorrel drink.

The natives of India are very fond of the flowers and leaves of *Clerodendron serratum*, which they eat as vegetables.

From the flowers or blossoms of the red gum tree (*Eucalyptus rostrata*), the natives of West Australia make a favourite beverage by soaking the flowers in water. The *Banksia* flowers are also so steeped to extract the honey. The natives are extremely fond of the infusion, and in the season their places of resort may be recognised by the small holes dug in the ground, lined with the bark of the tea tree, and surrounded with the drenched remains of the flowers, called by them man-gyt. They sit round this hole, each furnished with a small bunch of pine shavings, which they dip and suck until the beverage is finished.

From the flower of the Budjan shrub (*Dryandria Fraseri*) a nectar or honey is also obtained, much sought after by the natives.—*P. L. Simmonds, in the Chemist and Druggist.*

CORRESPONDENCE.

TRANSYLVANIA AS A SOURCE OF MEAT SUPPLY.

During a late journey in Austria and Hungary, I heard that one of our London meat-supply associations was about to establish slaughter-houses in Vienna, for the purpose of supplying our markets with killed meat, by means of a quick service of refrigerating cars, *viâ* Flushing. But, since the chief supply of cattle, sheep, and swine for Vienna comes from the Hungarian plains, or even the grazing lands of more distant Transylvania, I was induced to make a comparison of the prices of killed meat at the chief markets of Hungary and Transylvania. The results are most surprisingly in favour of Transylvania as a source of meat supply. The following prices are compiled from information given me by the Royal Statistical Bureau at Budapesth, and give the average price in kreutzers per Vienna lb. at the chief markets of Transylvania in the year 1874, the latest date at which I could obtain complete information:—

	Beef. Kreutzers.	Pork. Kreutzers.	Mutton. Kreutzers.
Kronstadt	19	27	13
Klausenburg	21	28	13
Herrmannstadt..	20	26	14
Rosenau	18	26	14
	78	107	54

Average in kreutzers, per Vienna lb.:—Beef, $19\frac{1}{2}$; pork, $26\frac{3}{4}$; mutton, $13\frac{1}{2}$. Average in pence, per English lb., exchange being 115 fl. = £10, and one Vienna lb. = 1·235 English lb.:—Beef, $3\frac{43}{100}$; pork, $4\frac{66}{100}$; mutton, $2\frac{38}{100}$; while the average rate at Pressburg, Pesth, and Vienna is fully 30 per cent. higher.

Meat can be forwarded all the way from Klausenburg to London, *viâ* Flushing, at a cost of about £7 10s. per ton, in quantities of not less than 10 tons. Surely, it would pay some of our meat companies to examine this matter, taking Klausenburg, in Transylvania, or Arad, or Grosswardein, at its gates, as their slaughtering places.

JOHN FRETWELL, Jun.

The American and Continental Agency, Limited,
3, New Basinghall-street, E.C., Nov. 30.

PROFESSOR BELL ON THE TELEPHONE.

I write to complain of the manner in which myself, like many other members of your Society, was disappointed at not being admitted to hear the paper last night on "The Telephone."

It certainly was a hardship for members to be excluded owing to the lecture-room being filled by persons of whom the greater number are not subscribers.

When papers of especial interest are brought before the Geographical Society, to which I belong, an arrangement has been made by which the number of admissions for members' friends is much curtailed.

Do you not think that some such plan could be recommended by your Committee for the sanction of the Society? This might tend to reduce the inconvenience and confusion to members at some future popular reading.

The least that can now be expected is, that Professor Bell should be invited to repeat his lecture at some early day to the members of the Society.

I shall be glad if you will insert this in your next *Journal.*

J. M. DUNN.

30, Claverton-street, S.W.,
29th November, 1877.

*** [It is desirable that it should be distinctly understood that the only persons present were members or the friends of members, admitted in accordance with the usual rule that every member has the right of introducing two friends to the ordinary meetings of the Society. In anticipation of an unusually large attendance applications to the Secretary for tickets, except in a few special instances, were refused, and the usual invitations issued on the part of the Council were restricted to the press, and to a very short list of scientific men interested in the subject. It is obvious that there would be difficulties in legislating for such unusual occasions as that of the 28th ult., and that, without some very general expression of such a desire on the part of the members, the Council would be very reluctant to restrict in any way existing privileges. It may, perhaps, be worth mention that not a single ticket was given to a private friend by the Secretary or the Assistant-Secretary.]

GENERAL NOTES.

Registration of Designs in Germany.—In September this year 8,517 designs and models were registered by 176 firms or individuals. Compared with August, this shows an increase of 5,828. Amongst the designs registered in August, were 4 of foreign origin—3 British and 1 French. There is an increase of 6,856 designs over September, 1876—making four times the number in that month. During 1877 there have been registered, up to the end of September, 37,525 designs. Since the commencement, the total number of registrations is 50,224. Among these were only 7 foreign, namely, 3 British and 4 French. It appears, therefore, that little heed is paid out of Germany to this important branch of trade registration there, one which cannot but have a very decided bearing upon industry. It is necessary to draw attention to the matter, since British manufacturers cannot be indifferent to seeing their designs and models protected abroad as well as at home.—*Trade Marks.*

The Telephone.—The Postmaster-General of the German Empire is about to have an extensive series of experiments made, with a view to the introduction of the telephone into the telegraphic service. Several hundred specimens of the telephonic apparatus manufactured by Siemens and Halske have been ordered. Mr. Bourdeaux, superintendent of the Submarine Telegraph Company at Dover, lately made important experiments with the telephone, instruments having been attached to the wire at St. Margaret's and at Sangatte, on the French coast. Talking could be heard, and also the playing of a musical box on the French coast.

NOTICES.

The Journal.

It is specially requested that, in case of any irregularity or delay in the delivery of the *Journal*, notice may be sent at once to the Secretary.

Ordinary Meetings.

Wednesday Evenings, at Eight o'clock. The following are the arrangements for the Meetings previous to Christmas :—

December 12.—"Freedom in the Growth and Sale of the Crops of the Farm considered in its bearings upon the Interest of Landowners and Tenant Farmers," by J. B. Lawes, Esq., F.R.S.

December 19.—"The Telephone," by Prof. A. G. Bell. Repetition of the former discourse.

Cantor Lectures.

Monday Evenings, at Eight o'clock. First Course, on "The Manufacture of Paper," Six Lectures by William Arnot, Esq., F.C.S.

Lecture III.—December 10th.

Washing, Bleaching, Beating, Loading, Sizing, Colouring.

Lecture IV.—December 17th.

Paper made by hand and by machinery. The Fourdrinier machine. Surface sizing. Drying machinery. Finishing.

Lecture V.—January 14th.

The Chemicals used in the paper mill; their nature, economical use, and methods of valuation. The recovery and re-use of soda as an economical process and in its sanitary bearings. The disposal of washing and machine waters, so as to minimise the pollution of streams.

Lecture VI.—January 21st.

The various classes of Paper; characteristic differences. The determination of the ash or loading. Water supply. General arrangement and construction of the mill.

Second Course, on "The Application of Photography to the Production of Printing Surfaces and Pictures in Pigment," by Thomas Bolas, Esq., F.C.S.

Third Course, on "Some Researches on Putrefactive Changes, and their Results in relation to the Preservation of Animal Substances," by B. W. Richardson, Esq., M.D., F.R.S.

Additional Lectures.

A Course of Three Lectures, on "Explosions in Coal Mines," will be delivered by T. Wills, Esq., F.C.S., on the three following Monday evenings, at Eight o'clock, January 28th, February 4th, and February 11th.

Lecture I.—January 28th.

The nature of the Coal Measures. Mining for coal. Ventilation of mines. Composition of coal. Occurrence of fire-damp or marsh gas in mines. Nature and properties of fire-damp. Dangers connected with its presence.

Lecture II.—February 4th.

After-damp or choke-damp. Methods adopted to allow of safe working in fiery mines. Various appliances for lighting mines. The nature of the safety lamp. Different forms of this lamp.

Lecture III.—February 11th.

Connection of the variations of atmospheric pressure with explosions in coal mines. Dangers attending blasting operations in coal mines. Action of coal-dust in certain classes of explosions. The use of the safety lamp as an indicator of the presence of fire-damp, also as a means for its quantitative estimation.

Juvenile Lectures.

A short Course of Two Lectures, suitable for a juvenile audienee, will be delivered during the Christmas holidays, by Prof. Barff, M.A., on "Coal and its Components." Special tickets will be issued for these lectures.

MEETINGS FOR THE ENSUING WEEK.

Mon.... **SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. W. Arnot, "Manufacture of Paper." (Lecture III.)
Farmers' Club, Caledonian Hotel, Adelphi, W.C., 5½ p.m. Mr. J. N. M'Adams, "The most Profitable Method of Feeding Cattle."
Society of Engineers, 6, Westminster-chambers, 7½ p.m. Annual General Meeting.
Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Prof. P. Martin Duncan, "The Formation of the Main Masses of the Land."
Medical, 11, Chandos-street, W., 8.30 p.m.
London Institution, Finsbury-circus, E.C., 5 p.m. Prof. Tyndall, "Certain Microscopic Organisms, their Genesis and Work in the World."

Tues....Metropolitan Association for Befriending Young Servants (at the House of the Society of Arts), 2.30 p.m.
Froebel Society for the Promotion of the Kindergarten System (at the House of the Society of Arts), 8 p.m. Miss Shirreff, "The Kindergarten in relation to the School."
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. James William Doherty, "Description of Coffer-dams used at Dublin, Birkenhead, and Hull."
Anthropological Institute, 4, St. Martin's-place, W.C., 8 p.m. 1. Mr. A. J. Jukes Browne, "Some Flint Implements from Egypt." 2. Mr. J. Park Harrison, "The Galleries of the Cave Pit, Cissbury, and recent Discoveries in its vicinity."
Royal Colonial, 15, Strand, W.C., 8 p.m. Mr. C. MacAlister, "Queensland and Chinese Immigration."

Wed.... **SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr. J. B. Lawes, "Freedom in the Growth and Sale of the Crops of the Farm, Considered in its bearings upon the Interests of Landowners and Tenant Farmers."

Thur....Royal, Burlington House, W., 8½ p.m.
East India Association, 20, Great George-street, S.W., 3 p.m. Gen. Sir Arthur Cotton, "The Prevention and Counteraction of Indian Famines."
London Institution, Finsbury-circus, E.C., 7 p.m. Mr. Clements R. Markham, "Greenland."
London Mathematical Society, 8 p.m. 1. Mr. S. Roberts "Notes on Normals." 2. Prof. Cayley, "The Geometrical Representation of Imaginary Quantities, and the Real (m, u) Correspondence of Two Planes."
Royal Historical, 11, Chandos-street, W., 8 p.m. 1. Mr. George Harris, "Domestic Everyday Life, Manners, and Customs in this Country, from the Earliest Period to the end of the Eighteenth Century (Part III.); the Anglo Normans;" Illustrated with Diagrams. 2. Mr. H. H. Howarth, "The Early Intercourse of the Danes and Franks (Part II)."

Fri.......Volunteer Sick Bearers' Association (at the House of the Society of Arts), 7 p.m.

Sat.......Working Men's Club and Institute Union (at the House of the Society of Arts), 4 p.m. Lecture by the Rev. Stopford Brooke.
Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Mr. S. P. Thompson, "Permanent Plateau's Films." 2. Mr. Sedley Taylor, "The Coloured Figures Exhibited by Vibrating Fluid Films."

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,308. Vol. XXVI.

FRIDAY, DECEMBER 14, 1877.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

PROFESSOR BELL ON THE TELEPHONE.

In consequence of the large attendance expected on the evening of Wednesday, the 19th December, when Prof. Bell will repeat his lecture on the Telephone, the Council have made arrangements for the lecture to be delivered in the Great Hall of the Freemasons' Tavern, Great Queen-street, W.C., instead of at the Society's House.

Every Member can admit two friends to the Meeting by means of the usual ticket, or by personal introduction. Members will be admitted on signing their names.

The chair will be taken at the usual hour, 8 p.m.

SILVERSMITHS' WORK.

The Council offer the sum of £100 (placed at their disposal by Messrs. Watherston and Son), together with the Society's medal, for "The best essay on the Art of the Silversmith, past and present, of all nations, with practical suggestions for its future developement."

The essay must be historical as well as practical, and should point out the *chefs d'œuvre* produced in various countries.

It is necessary that the obstacles which have tended to retard the progress of the art in England should be set forth, with a view to their removal, and that suggestions should be made for improvements in the various branches of the art.

The names of the judges will be published hereafter.

The premium will not be awarded unless an essay of sufficient merit is submitted.

FOURTH ORDINARY MEETING.

Wednesday, December 12th, 1877; William Hawes, F.R.S., Deputy Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Bragge, William, Shirle-hill, Hamstead-road, Birmingham.
Crease, Major John Frederick, Eastney-barracks, Portsmouth.
Crisp, Frank, F.L.S., 5, Lansdowne-road, Notting-hill, W.
Downing, Nicholas Berriman, Eastfield-lodge, Walthamstow.
Glover, Henry, Wellington-road, Bow, E.
Lumsden, David, Telegraph Department, General Post-office, E.C.
Ramson, Tarrar, Lowestoft.
Shakespear, Colonel John D., F.G.S., Scientific Club, 7, Savile-row, W.
Whitmore, Lawrence Hersee, 124, Sloane-street, W.

The following candidates were balloted for and duly elected members of the Society:—

Bramston, John, Colonial Office, Whitehall, S.W.
Carteighe, Michael, F.C.S., 180, New Bond-street, W., and 81, Mornington-road, N.W.
Cullen, William Hart, jun., 13, Victoria-road, Holloway, N.
Hewan, Archibald, M.D., 9, Chester-square, W.
Kenrick, William, Mayor of Birmingham.
Postans, Arthur William, F.C.S., 35, Baker-street, Portman-square, W.
Reid, Patrick Sandeman, 20, John-street, Adelphi, W.C.
Sabel, Ernest E., F.R.G.S., 85, Cannon-street, E.C., and 185, Maida-vale, W.
Sabel, Paul, 85, Cannon-street, E.C.
Smith, James S., 12, Worship-street, E.C.

The paper read was—

FREEDOM IN THE GROWTH AND SALE OF THE CROPS OF THE FARM, CONSIDERED IN RELATION TO THE INTERESTS OF THE LANDOWNER AND THE TENANT-FARMER.

By J. B. Lawes, LL.D., F.R.S., &c.

The agriculture of Great Britain, considered as a commercial undertaking, may be said to be carried on by two partners; the one providing the capital in land and buildings, and the other the capital in live stock, implements, manures, and that required for the payment of wages, &c. The interest of the one partner is permanent; he may be called the owner of the business; whilst that of the other is limited to a period mutually agreed upon. The landowner receives interest upon his capital in the form of a fixed annual payment, or rent. The profits of the tenant, on the other hand, are fluctuating, for they depend, not only on the fixed amount of rent paid, but upon whether the seasons are favourable or unfavourable, upon his skill in management, and upon a variety of other circumstances. The tenant gets a higher rate of interest on his capital than the landowner, as is to be expected that he should do, since he takes a more active share in the management of the business. The landowner, however, controls some of the most important operations on the farm. He decides what crops may, and what crops may not, be grown; what produce may be sold, and what may not be carried off the farm. The tenant attends to the cultivation of the land, buys and sells stock, and, subject to the important restrictions above-mentioned, manages the farm in the manner which he considers the most conducive to his own interests.

It is frequently assumed that the interests of

the landowner and of the tenant are somewhat conflicting; and much of the reluctance of the tenant to furnish statistics arises from a fear that the knowledge thus provided would induce the landowner to demand a larger share in the profits of the business. It appears to me, however, that the interests of the landowner and the tenant are, in every respect but one, identical. The tenant acts like any other man of business. After providing for the maintenance and education of his family, he saves as much as he can to place them out in life. A farmer's son generally becomes a farmer. If the capital of the farmer be reduced, a reduction of rent is sure to follow, sooner or later. With large profits, on the other hand, there is an increase in the amount of capital to be invested in farming, there is more competition for farms, and rents rise. Excepting in the form of loans by bankers to farmers, probably not much capital goes into the business of farming from external sources. A certain amount is brought into it by those who, having been successful in other pursuits, take up with farming; but whether they are generally successful in making a profit out of it is very doubtful. Their farming must rather be classed with that of the landowner, who derives little other benefit from it than the pleasure which the occupation affords.

I have said that the interests of the landowner and the tenant farmer are identical in every respect but one. Those of the landowner are permanent, whilst those of the tenant are limited. Accordingly, with a view of maintaining the fertility of his soil, the landowner introduces into his agreements certain restrictive covenants, in regard to cropping, and to the sale of the produce of the farm. He argues that any profit which might accrue to the tenant from the removal of such restrictions, would be obtained at his expense, and would reduce the letting capability of his land. It must be conceded by the tenant that, as such restrictions, have been in force for so long a time, the burden of proof that they might be removed without injury to the landowner rests upon him, or upon those who advocate his claims.

This brings me to the special subject of my address to you this evening, namely—freedom in the growth and sale of the crops of the farm, considered in relation to the interests of the landowner and the tenant farmer.

The restrictions introduced into the covenants by the landowner for his protection may be briefly summed up as follows:—

Not to grow two white straw crops in succession.

Not to sell straw, hay, roots, or, in fact, any fodder crops off the farm.

In some districts a second white straw crop in succession may be taken in the course of a rotation; that is to say, three in five years, instead of two in four years. In such cases, it is generally stipulated that the second corn crop shall differ from the first; that wheat shall not follow wheat, nor barley barley.

In regard to these restrictions, I propose to consider the following questions:—

Are they necessary for the protection of the landowner?

If once necessary, are they equally so now?

Does a comparison between past and present prices of agricultural produce, or our increased knowledge in regard to the action of manures, and to the exhaustion of soils, or the fact that large external sources of supply of fertilising materials are now at our command, justify us in concluding that these restrictions might safely be modified, or even in some cases removed?

The arguments for and against the modification or removal of restrictive covenants, may be briefly stated thus:—

ON BEHALF OF THE LANDOWNER.

That long experience has shown such restrictions to be necessary to prevent undue exhaustion of the soil.

That to give power to the tenant to grow what crops he pleases, and to sell straw, hay, roots, and fodder crops generally, would exhaust the land, be prejudicial to the interests of a succeeding tenant, and would render the letting of the farm more difficult, if not actually reduce its letting value.

That even if the tenant were permitted to grow and sell what crops he pleased, it would not be to his interest to do otherwise than he is now allowed to do.

That, all things considered, restrictive covenants are beneficial to both the landowner and the tenant.

ON BEHALF OF THE TENANT.

The restrictions on the sale of straw, hay, &c., artificially enhance the prices of those commodities, are therefore injurious to the consuming public, and amount to protection in favour of the few farmers who are permitted to sell them.

That, in the event of the outgoing tenant having the power to sell all the products off the farm, the incoming tenant could still purchase all he required; since, having no carriage for removal to pay for, he would have the advantage over all other purchasers.

That restrictive covenants prevent the tenant from applying his skill and capital to the best advantage.

That at least, in a large majority of cases, the modification or removal of existing restrictions would not prove injurious to the more permanent interests of the landowner.

In these few paragraphs, I have endeavoured to summarise the arguments which would probably be used against or for any change in the usual restrictive covenants. I have, however, omitted from those which the tenant might adduce in favour of change some which, whilst they would materially strengthen his case, I should perhaps hardly be justified in making him responsible for. If we compare the agriculture of the present day with that of half or three-quarters of a century ago, we shall notice some changes which are evident to all. The actual and relative prices of meat, grain, straw, and hay, are very different now from what they were then. The farmer has now at his command enormously increased and increasing supplies of purchasable cattle foods and manures. There are other changes which are not so obvious at first sight, but which are equally important, such as our greatly increased knowledge of the action of manuring substances, and of the capabilities and of the exhaustion of soils.

The agriculture of the last century consisted of

little else than taking several corn crops in succession, until the produce did not pay the cost of cultivation, and then allowing the land to recover its fertility by rest. During this period it afforded scanty food for stock. After a time it was again broken up; and so on. As population and the demand for food increased, the periods of rest were shortened, and the land was rarely left more than two or three years in succession without being ploughed up and a corn crop sown. Still later, a rotation of crops, which required the land to be broken up every year, was adopted.

Under this more modern system, the demands upon the soil would obviously be greater; and, accordingly, it was considered expedient to place some restriction upon the course of cropping and the sales by the tenant, to prevent him from sending off the farm too much of the produce of the soil. By degrees such covenants became almost universal, and at the present time very few tenants are allowed perfect freedom of action.

Looking at the various things which a farmer may and may not do, it is difficult, if not impossible, to give any rational explanation of their adoption. Some things which he is permitted to do, and which are considered consistent with good husbandry, may be as exhausting to the soil as the growth of a second corn crop, or the sale of straw. Thus, deep cultivation, liming, draining, and bare fallow, have all for their object to enable the farmer to take more out of the soil without putting anything into it. On the other hand, very few farmers find it to their interest to exhaust the land as much as they are permitted to do under the provisions of their leases or agreements. Whether they purchase cattle food, or manures, or not, they generally consume on the farm a portion of the corn which they might, if they please, carry to market. It is, indeed, only soils of high natural fertility that can furnish sufficient produce to pay rent and the expenses of cultivation, and also yield a profit to the tenant, without some aid from external sources.

It is now more than forty years since I commenced experiments at Rothamsted, with different manuring substances, first with plants in pots, and afterwards in the field; and I have the record of more than eighty different chemical substances, or combinations, having been tried in one year in the very early days of those experiments. In the course of their extended and continued prosecution up to the present time, it has been found that some of the most important crops of the farm can be grown for twenty, or even more than thirty, years in succession on the same land, in full agricultural quantity, by means of chemical salts alone, of which the three most important constituents are nitrogen, phosphoric acid, and potass. As during the whole of the long periods mentioned manures supplying these substances have been used, in some cases separately, and in others in various combinations, year after year, on the same plot of land, and with the same crop, it is obvious that the results obtained have furnished the basis for forming a pretty accurate judgment of what constitutes exhaustion of the soil. They also enable us to determine which of the constituents of the crops are derived from the atmosphere, and which must be supplied by, and are taken from, the soil.

Time will not permit me to direct your attention to the results of these experiments except in the briefest possible manner. At the outset I must observe that the experiments to which I am about to refer are conducted without reference to the question of economy or profit; and I must beg you, therefore, to dismiss from your minds any consideration as to their cost. What I wish to illustrate, and to impress upon your minds, is that the three constituents of manures — nitrogen, phosphoric acid, and potass—are not only the most effective on the growth of crops, and, therefore, the most important, but they are also those which, in proportion to the requirement for them, are generally contained in only small available amount compared with the other constituents of crops which are derived from the soil. The economical application of these essential elements of plant food is a subject which would require entirely separate consideration. It would involve an inquiry into the relative economy of manure made by stock and that purchased from external sources; into the natural fertility of soils, or their capability to yield up annually more or less of plant food; and into the prices at which straw, hay, roots, &c., could be more profitably consumed on, or sold off, the farm.

Permanent Grass.—The application of artificial manures alone, containing nitrogen, phosphoric acid and potass (with some other constituents of known little effect), for twenty-two years in succession, has given an average annual crop of hay of nearly three tons per acre. Twice during the period a second crop has been cut without further manuring; and it has, on each occasion, yielded nearly $2\frac{1}{2}$ tons more.

Permanent Wheat.—In like manner, artificial manures used alone, supplying nitrogen, phosphoric acid, and potass, have given an average, over twenty-five years, of $36\frac{3}{4}$ bushels of dressed corn, and more than 2 tons of straw, per acre per annum. The produce of the present year was 40 bushels of dressed corn, and 1 ton 14 cwts. of straw. No dung has been applied to this land for 38 years.

Permanent Barley.—In a similar way, artificial manures alone, containing nitrogen and phosphoric acid, *without potass*, have given an average, over 25 years, of 6 quarters of barley, and nearly $1\frac{1}{2}$ ton of straw, per acre per annum. Another plot, with the same amounts of nitrogen and phosphoric acid, but with potass added, has given, on the average, only a fraction of a bushel more corn, and less than 2 cwts. more straw, per acre per annum. No dung has been applied to this land for 30 years. It is evident, therefore, that, up to the present time, the soil itself has yielded up as much potass as was required for the large annual crop abovementioned.

Permanent Root Crops.—Root crops are generally considered to be more dependent on applied manure than any other; and this opinion is fully confirmed by the Rothamsted experiments. In a continuously unmanured four-course rotation, which has now extended over a period of 30 years, the root crop of the first course, though small, was very much heavier than it has been since, having been quite insignificant, and averaging less than a ton per acre per annum, over the last six courses. Notwithstanding this, the barley averaged $36\frac{1}{4}$ bushels, and the wheat 30 bushels over the seven unmanured courses.

With the exception of three years, during which barley was grown without manure, roots have been grown over an area of 8 acres, without manure, with farmyard manure, and with different artificial manures, from 1843 up to the present time, as under:—

Norfolk whites	6 years.
Swedes	4 ,,
(Barley)	(3) ,,
Swedes	15 ,,
Sugar-beet	5 ,,
Mangels	2 ,,
Roots, total	32 years.

In the case of the Norfolk whites and Swedes, the leaves as well as the roots were removed from the land; but in the case of the sugar-beet and mangels, the leaves were spread upon the land, and the roots only were removed. In 1876, the produce of roots (mangels) with artificial manure alone, containing nitrogen, phosphoric acid, and potass, was 22 tons 11 cwts., and in the present year, 1877, it has been 22 tons 2 cwts. No dung has been applied to these plots for nearly 40 years.

Some specimens of the produce of the present season, grown with artificial manure alone, on land which has not received any dung for so many years, are to be seen on the table. Compared with the monsters which you are accustomed to see exhibited, these are of very moderate dimensions. They are grown very close together, 26 inches between the rows, but only 11 inches from plant to plant in the rows. Such roots will, however, contain a much higher proportion of dry or solid matter than larger ones; and samples from the same plots as those before you have this year given to analysis from 9 to 10 per cent. of sugar, or more than the amount of total dry or solid substance in many monster roots.

From these few illustrations, it must be evident to you, that manures supplying nitrogen, phosphoric acid, and potass will keep up the fertility of my soil, and enable it to produce crops of hay, corn, and roots, in full agricultural quantity, for very many years in succession. Nor is this result dependant on anything exceptional in the quality of my particular soil; on the contrary, I do not hesitate to give it as my opinion, that cultivated soils generally, whether in Great Britain or elsewhere, which have become impoverished by cropping, would, in a greater or less degree, be restored to fertility by the application of manure supplying, in an available condition, one or more of the three constituents, nitrogen, phosphoric acid, and potass.

It may be said roughly that from 90 to 95 per cent. of the dry substance of the crops I have referred to, as grown by artificial manures alone, consisted of organic matter of which the manures applied contained none. There can be no doubt that the constituents of this organic matter were derived, directly or indirectly, from the atmosphere, and not from either the soil itself or the manures. And if a system of compensation to outgoing tenants for unexhausted manures should at any time be generally adopted and enforced, there can be little doubt that the three constituents of crops, soils, and manures, to which I have especially directed your attention, will alone be admitted as subjects of claim; and the difficulty of estimating the amount of them remaining in the soil in a condition capable of being yielded up to growing crops within a definite period of time, will tax to the utmost the knowledge and skill of the valuer or arbitrator.

Assuming then, that nitrogen, phosphoric acid, and potass, are the most important constitents of manures, and are those in which our soils are the most likely to become deficient by indiscriminate cropping, let us see how the stores of them within the soil are affected under the adoption of an ordinary four-course rotation, subject to the restrictive covenants usually enforced.

It was due to the sagacity of the father of the present Earl of Leicester, that this system of rotation was brought into general use on the light lands of Norfolk. At the commencement of the present century, large areas of those soils, which are now extremely productive, were considered to be not worth cultivation. In themselves they were very poor in the elements of fertility, and very little could be purchased from external sources. Consequently, it was of the utmost importance that the sales should be so regulated that a minimum amount of the most essential fertilising constituents should be given in exchange for a given amount of money. In other words, that for the same amount of money received by the tenant for his produce, he should export from the soil as little as possible of the constituents essential for the growth of future crops.

In the following table is shown the amounts of nitrogen, phosphoric acid, and potass, that would be lost to the farm in the disposal of different kinds of produce, in equal money value, reckoned according to the prices prevailing sixty or seventy years ago; and for convenience of illustra-

Constituents contained in £10 worth of each Description of Produce, reckoned at the Prices of Sixty or Seventy Years ago.

Produce the Sale of which is Allowed.

Produce.	Nitrogen.	Phosphoric acid.	Potass.	Total.
	lbs.	lbs.	lbs.	lbs.
Live weight of animal	18·0	10·0	1·3	29·3
Wheat grain	27·0	13·0	8·0	48·0
Barley grain	24·0	12·0	8·0	44·0
Oat grain	30·0	9·5	7·0	46·5
Average	24·8	11·1	6·1	42·0

Produce the Sale of which is Prohibited.

Produce.	Nitrogen.	Phosphoric acid.	Potass.	Total.
	lbs.	lbs.	lbs.	lbs.
Clover hay	120·0	32·0	103·0	255·0
Meadow hay	80·0	23·0	90·0	193·0
Wheat straw	58·0	32·0	85·0	175·0
Barley straw	65·0	27·0	110·0	202·0
Oat straw	70·0	25·0	120·0	215·0
Average	78·6	27·8	102·0	208·0

tion, £10 worth of produce is assumed to be sold in each case. In the upper division of the table are enumerated those products which, according to the usual restrictive covenants, may, and in the lower division those which may not, be sold off the farm.

It will be seen how admirably a system of rotation, with covenants permitting the sale of meat and grain, but prohibiting the disposal of hay or straw, was calculated to conserve the three important constituents of soils and manures —nitrogen, phosphoric acid, and potass. Thus, of nitrogen, by the sale of £10 worth of meat, the tenant would only send off the farm 18 lbs., whereas in £10 worth of clover hay he would export 120 lbs., and in £10 worth of meadow hay, 80 lbs. Of phosphoric acid, in £10 worth of meat, he would send off only 10 lbs; but in £10 worth of clover hay, 32 lbs, and in £10 worth of meadow hay, 23 lbs. Of potass, in £10 worth of meat, he would send off only 1⅓ lbs, and in £10 worth of clover hay, 103 lbs, and in £10 worth of meadow hay, 90 lbs. Again, of nitrogen he would only send off from 24 to 30 lbs. in £10 worth of wheat, barley, or oat grain; whereas in £10 worth of wheat, barley, or oat straw, he would export from two to three times as much. In £10 worth of wheat, barley, or oat grain, he would sell from 9½ to 13 lbs. of phosphoric acid; but in wheat, barley, or oat straw to the same value, he would sell about twice and a half as much. Lastly, of potass, there would be in £10 worth of wheat, barley, or oat grain, only 7 or 8 lbs.; but in £10 worth of wheat, barley, or oat straw, considerably more than ten times as much.

Leaving out of view the details, and confining attention only to the lines of mean results in the table, it will be seen that, by the disposal of £10 worth of the produce, the sale of which is prohibited, there would, on the average, be more than three times as much nitrogen, about two and a half times as much phosphoric acid, and more than sixteen times as much potass lost to the farm, as in £10 worth of the produce, the sale of which is allowed.

Thus, modern science not only confirms the value of a system introduced about three quarters of a century ago, but it shows clearly upon what its value really depended.

In the next table is shown the amounts of nitrogen, phosphoric acid, and potass, in £10 worth of each of the same descriptions of produce, reckoned according to their fair average selling price in recent years.

It will be observed that, at the present day, the farmer gives much less of the three constituents in live weight of animal, hay, or straw, for £10, than he did three-quarters of a century ago; or, in other words, the prices of these articles are much higher now than they were then. On the other hand, wheat, barley, and oat grain, are cheaper now than they were then, and he has to give more of them, and of their important constituents, for the same money, than he did formerly.

The fact is, that, by the sale of £10 worth of straw, the exhaustion of nitrogen would, at the present time, be only about the same as by the sale of £10 worth of grain, whereas formerly it was from two to three times as great. Of phosphoric acid, again, the loss to the land, by the sale of £10 worth

Constituents contained in £10 worth of each description of Produce reckoned at the average prices of recent years.

PRODUCE THE SALE OF WHICH IS ALLOWED.

Produce.	Nitrogen.	Phosphoric acid.	Potass.	Total.
	lbs.	lbs.	lbs.	lbs.
Live-weight	9·0	5·0	0·65	14·7
Wheat grain....	36·0	17·3	10·7	64·0
Barley grain	32·0	16·0	10·7	58·7
Oat grain	40·0	12·7	9·3	62·0
Average	29·3	12·8	7·8	50·0

PRODUCE THE SALE OF WHICH IS PROHIBITED.

Produce.	Nitrogen.	Phosphoric acid.	Potass.	Total.
	lbs.	lbs.	lbs.	lbs.
Clover hay......	72·0	19·2	61·8	153
Meadow hay	64·0	18·4	72·0	154
Wheat straw....	32·4	17·9	47·4	97
Barley straw....	36·3	15·1	61·4	113
Oat straw	39·1	14·0	67·0	120
Average	48·8	16·9	61·8	127

of straw, is now only about the same as by the sale of £10 worth of grain, whereas formerly it was more than twice as great. Lastly, of potass, whilst formerly considerably more than ten times as much would be sold off in £10 worth of straw than of grain, at the present time only between five and six times as much would be exported in £10 worth of straw as in £10 worth of grain.

Again, calling attention to the mean results only, you will see that, in consequence of the change in prices which has taken place between the two periods, the amount of nitrogen now sold off in £10 worth of meat or grain would be 29 lbs., whilst that in the same value of the produce the sale of which is prohibited would be 49 lbs., or little more than one and a-half time as much; whilst formerly it was more than three times as much. Of phosphoric acid the average amount in £10 worth of the saleable products would, at the present time, be under 13 lbs., and in that of the prohibited products about 17 lbs., or less than one and a-half times as much in the latter; whilst, at the former period, it was two and a-half times as much. Of potass, £10 worth of the saleable products would now contain, on the average, under 8 lbs., whilst the prohibited products would contain 62 lbs., or about eight times as much; whilst formerly £10 worth of the prohibited product contained 16 times as much potass as the same value of the saleable product.

The obvious result of all this is, that, at the present prices of the different descriptions of produce, the tenant would exhaust the land of nitrogen, phosphoric acid, and potass, very much less by the sale of £10 worth of meat than he would, three quarters of a century ago, by the sale of a given money's worth of grain, and much less by the sale of a given money's worth of hay or straw, now than formerly; so that, to compensate for such sale of hay or straw, it would be necessary to import less of

these constituents from external sources at the present time than at the former period.

To illustrate the matter in a practical way, let us assume that the farmer of 1807, and the farmer of 1877, were each permitted to sell the products the sale of which is at present prohibited, on condition that he purchased and brought on to the land the amount of nitrogen, phosphoric acid, and potass, which he carried off in the produce sold. Of course this would have been impossible in the case of the farmer of 1807, as the necessary artificial manures were not then in the market. But, assuming that the same sources were available to him, and at the same prices as at present, how would the case stand? After selling £10 worth of the produce the sale of which is now prohibited, the farmer of 1807 would have to expend about 111 shillings to restore the constituents exported, leaving him only 89 shillings out of the £10 received. The farmer of 1877, exporting much less in £10 worth of these products, would have to expend only about 69 shillings to return the nitrogen, phosphoric acid, and potass, retaining in his pocket 131 shillings of the £10 he had received, or about $1\frac{1}{2}$ times as much.

At the time when the four-course rotation and the restrictive covenants connected with its adoption were introduced, nothing was, however, known of the importance of nitrogen, phosphoric acid, and potass. Between the years 1805 and 1812, Sir Humphrey Davy delivered a course of lectures on agricultural chemistry, in which was embodied all the best knowledge of the day relating to the subject. He does, indeed, mention nitrogen, phosphoric acid, and potass, in various parts of his lectures; and even quotes experiments on vegetation, which he made with saline substances containing them; but still he seems to attribute comparatively little importance to them as constituents of soils or manures. Referring to the mud of the Nile as an example of one of the best natural soils, he gives an analysis of it by a French chemist, in which neither of these important constituents is mentioned. Speaking of fallow, he says:—"The vague ancient opinion of the use of nitre and of nitrous salts in vegetation, seems to have been one of the principal speculative reasons for the defence of summer fallows." Sir Humphrey Davy's lectures appear to have excited very little attention among agriculturists, and to have exerted little or no influence on agriculture. In fact, from the date of his lectures up to the appearance of Liebig's first work on the subject in 1840, a period of about 30 years, the application of chemistry to agriculture was little thought of in this country. It is somewhat remarkable that, during the time when Sir Humphrey Davy was delivering his lectures, he and other eminent scientific men of the day were accustomed to visit in the adjoining parish to that in which I reside, at the house of Sir John Sebright, the grandfather of the present baronet. Sir John attained considerable eminence as an agriculturist, especially as a breeder of stock; and he informed me that the subject of the application of chemistry to agriculture was frequently discussed at those gatherings, and the general opinion was that little or no benefit would result from it.

Exhaustion of the Soil.

Some years ago, I read a paper before the London Farmers' Club, in which I endeavoured to define what is known in agricultural language as "condition" of soil, and to draw a distinction between it and what may be called the natural fertility of the land. "Condition" I described as representing those fertilising matters within the soil which had been accumulated within it by the operations of the tenant. It was to the value of these that it was the intention of the framers of the Agricultural Holdings Act, to give the outgoing tenant a legal claim. The almost complete evasion of that Act appears to be due to a fear that the great ignorance which exists as to the effects of unexhausted manures, might lead to large and unjust claims being put forward or awarded, rather than to any desire to deprive the tenant of that which is justly his. That such a fear is not altogether devoid of foundation, my experience when called as a witness in connection with a claim for compensation in Ireland sufficiently proves. If, however, a tenant had freedom of action as to cropping and the disposal of his produce, he would have little cause to trouble himself about compensation for unexhausted manures.

From the point of view of practical agriculture, exhaustion of the soil may be defined as such a condition brought about by the removal of crops, that a good or profitable crop of the same description of produce as the one last taken, cannot be grown without fresh manuring. For example, in most descriptions and conditions of soils, a growing corn crop will so far exhaust the nitrogen available for such crops within its reach, that a second corn crop would find a deficiency of it unless it were supplied by manure. In fact, in almost all cases, a supply of available nitrogen by manure would largely increase the growth of a second corn crop. Assuming that a second corn crop were so taken, and the straw as well as the corn sold off the farm, there would obviously be a large export of phosphoric acid and potass; but to what extent the soil would, in an agricultural sense, be "exhausted" thereby, would entirely depend upon the "natural fertility," and the "condition" of the particular soil. The question of in what degree, or in what way, restoration should be made, is one for the exercise of the judgment and intelligence of the tenant, founded on his knowledge and experience of the quality and condition of his soil.

After very careful consideration of the subject, I am disposed to conclude that no stipulation on the part of the landowner, to the effect that a given quantity of manure, natural or artificial, shall be brought upon the farm from external sources for a given quantity of produce exported, would be generally applicable, or obviate the difficulty supposed. There would be no difficulty in estimating the amounts of nitrogen, phosphoric acid, and potass, sent off the farm in known descriptions and amounts of produce; nor would there be any in determining in what descriptions and amounts of manure the constituents exported in the produce could be replaced. But, to use a common expression, such an arrangement "would not work." Indeed, the clause often introduced into agreements, binding the tenant to bring back rotten dung, or an "equivalent" in artificial manure, might be so taken advantage of as to reduce rather than to restore the fertility of the soil.

In reference to to the subject of the restoration of

the constituents removed, I may quote an extreme case by way of illustration. On one of the experimental plots at Rothamsted, the potass of both the straw and the corn of 25 large crops of barley has been removed from the land without any restoration of potass during the whole of the period. On another plot in the same field, potass has been applied in addition to the same manures every year, for 25 years in succession, without increasing the crop more than by a fraction of a bushel of corn, and about $1\frac{1}{2}$ cwt. of straw, per acre per annum. It surely would be unreasonable to call upon the tenant to be at the expense of replacing the potass of the exported produce in purchased manures, if the soil itself were competent to supply the amount required. It is true that we are, at present, very ignorant in regard to the resources of various descriptions of soil; and it is quite certain that very many soils could not yield the amount of potass which has been taken from my soil, in the case I have just cited. But assuming a soil to be deficient in available potass for the crops the tenant wished to grow, would not he, rather than the landowner, be the sufferer if he attempted to grow them without supplying it? If he were at the expense of supplying sufficient available nitrogen and phosphoric acid to produce the crops he desired, assuming the soil to contain an abundance of potass, and if, instead, the soil were deficient in potass, the manures he did apply would not have their full effect, and he would incur a corresponding loss of money in the operation.

If the motto, "Practice with Science," have any real significance as applied to agriculture, the union of the two should at least teach the lessons that the resources of the soil itself are to be turned to profitable account; that those constituents which the soil itself will yield in abundance need not be added; but that those in which it is deficient should be applied to it in the cheapest possible way. Experience alone can teach the farmer what are the resources of the soil with which he has to deal. Light land farmers know full well that the inherent resources of their soils have a limit which is very soon reached; that a too liberal use of nitrogen, in the form of nitrate of soda, is liable to be followed by mildew, or a laid crop; and they are thus warned that they cannot, without loss to themselves, disturb the healthy balance of plant food.

The soil of many of the experimental plots at Rothamsted has been subject to a degree of exhaustion, such as cannot possibly take place under any conceivable system of commercial agriculture. But the growth of corn, hay, or root crops, year after year on the same land, for a quarter of a century or more, without manure, with individual manures, and with various combinations, has provided important data for judging of the available resources of that and of similar soils. Looking to the very various condition of the different plots so differently treated, the interesting question suggests itself—whether, if each of them could be magnified into a farm of 100 acres, with the history of its treatment attached to it, the purchasing or letting value would be different in the different cases?

It is quite certain that the most experienced land-valuer could not detect any visible difference between the land which has grown wheat or barley for 25 years or more with superphosphate of lime, and salts of potass, soda, and magnesia, and that which has grown the same crop with salts of ammonia alone. He might, perhaps, observe a difference in the stubble, but that would be in favour of the plot exhausted of potass and phosphoric acid by the continual use of ammonia salts alone, rather than of that to which an excess of the mineral constituents had every year been added without nitrogen. Compared with the land of neighbouring farms, the chief difference he would observe would be a marked freedom from weeds on the experimental plots. For myself, after much consideration of the subject, I feel that I should have extreme difficulty in assigning a higher letting value to land corresponding in condition to that of one plot rather than to that of another, or in fixing a different rental from that of similar land in the neighbourhood. At any rate, the difference would be but slight, and would be applicable for only a short period of time. The land in my immediate locality is not, as a rule, kept in high condition, nor very clean, and I am disposed to think that the comparative freedom from weeds of the more exhausted experimental land at Rothamsted would compensate for any loss of condition which it may have sustained by the treatment to which they have been exposed, and that I should give it the preference on that account.

For my own information, and for that of the numerous agriculturalists who visit Rothamsted every summer during the growth of the crops, I have grown many more corn crops in succession, by means of purchased manures, on most of the land on my farm not under continual experiment, than I should think of doing if my only object were profitable farming, or than could possibly be done by farmers generally; and I think the unanimous opinion of the many practical farmers who inspect the crops so growing at Rothamsted, would be that the land is surprisingly clean, and that there is no evidence of exhaustion such as they would expect to see under the circumstances.

The sources of supply, external to the farm itself, of nitrogen, phosphoric acid, and potass, may be briefly summarised as follows:—

Nitrogen.—The sources of supply of nitrogen, at present known, are more limited, in proportion to probable future requirements, than those of either phosphoric acid or potass. There are, however, vast deposits of nitrate of soda in Peru and Bolivia. Those in Bolivia have not as yet been worked. At present, the other supplies are more than equal the demand. A future generation of British farmers will, doubtless, hear with some surprise that, at the close of the manure season of 1876, there were 40,000 tons of nitrate of soda in our docks which could not find purchasers, although the price did not exceed £12 or £13 per ton. Peruvian guano, sulphate of ammonia, and soot, are manures which also supply large quantities of nitrogen. The consumption of purchased cattle foods is another large and increasing source of supply of nitrogen to our soils.

Phosphoric Acid.—The external sources of phosphoric acid, once limited to that in bones, are now very extensive; and the supplies of it from

various mineral deposits throughout the world are quite equal to any demand for it that is likely to arise.

Potass.—Until within the last few years, the chief source of potass was wood ashes, and this supply would have been quite insufficient to meet any large demand for it for manure. The discovery, in Prussia and Anhalt, of vast deposits of salts of potass, mixed with salts of soda and magnesia, has greatly increased the supply, and lowered the price of potass in the market. A company has recently been formed, which has acquired the right to work extensive newly discovered deposits in Germany. From their prospectus it appears that the area of their concessions has already been proved to contain enough of crude potass salts to supply the whole of the arable land of Great Britain with very many tons per acre.

These large external sources of supply of nitrogen, phosphoric acid, and potass, which were unknown to a former generation of farmers, would afford the means of adequate restoration to the land under a very much less restrictive system, both as to cropping and sales of produce, than that which now prevails, and is considered essential for the maintenance of the fertility of our soils. It is generally supposed that larger quantities of both corn and meat are produced upon a given area of land in Great Britain than in any other country. With concentrated production, agriculture ceases to be a mere process of sowing and reaping. It becomes a process of manufacture, involving numerous complicated problems, for the solution of which the aid of science is necessary, and should be gladly welcomed. The importance of science to agriculture is, however, more fully recognised in several other countries than in our own. Even the farmers of the United States, who, with their vast area of virgin soil, are able to supply us with both corn and meat at prices which we find it difficult to contend against, have their *Journal of Scientific Agriculture*, and they are generally much better acquainted with the investigations in progress at the different agricultural stations on this side of the Atlantic than are our own farmers.

May we not attribute some of the indifference to the teachings of science, which is displayed by the British agriculturist, to the influence of the restrictive covenants under which he works? May not the farmer, argue with some show of reason, that it is useless to trouble himself about scientific principles, so long as his landlord places a veto upon his application of them to practice?

If it be true, as I said at the commencement, that the interests of the landowner and the tenant are intimately connected, and mutually dependent, rather than conflicting, and that the tenant cannot suffer loss without injury, sooner or later, overtaking the landowner, the present time would seem to be very appropriate for considering whether the restrictions on cropping and sales might not, with advantage to both, be materially modified, or even in some cases entirely removed? The last few years have entailed serious losses upon the business of farming. Owing to cattle diseases, and other causes, the live-stock of the country has diminished. I have myself, for the last three years in succession, recorded in the *Times* a wheat crop much below the average; whilst, until quite recently, the price has been kept down by large imports. Further, there has been a considerable increase in the cost of labour, without a corresponding increase in its efficiency. All these unfavourable circumstances have pressed heavily upon farmers; and it is generally believed that an unusually large number of farms are just now thrown upon the hands of the landowner. It is to be feared that many tenants have been living upon their capital, and that it is only the fortunate few who have of late years been able to lay by any money.

I would not say that freedom of action as to cropping and sales would be a complete remedy for all these adverse circumstances; nor should I wish to see it granted indiscriminately. But I do not hesitate to say that, if I entered upon the business of farming to make money, I could not conduct it to the best advantage without such freedom. If there are many farmers who have too little knowledge and intelligence to comprehend the requirements of an improved system of agriculture, and have too little capital to carry it out with success, there are, on the other hand, many who possess both the requisite intelligence and the requisite capital. It is on their behalf that I would address the owners of the soil. But, in proposing the relaxation or abandonment of long-established restrictions, I would not by any means assume that the tenant alone will reap the benefit. Not only the producer, but the consumer—the public at large—must derive advantage from an improved and more productive system of agriculture. Nor could these results follow without favourably reacting upon the interests of the landowner.

Since restrictive covenants were first generally established, great changes have taken place in almost every important element of the question involved. There have been changes in the actnal and relative prices of the various products of the farm. There has been advance in our knowledge of the capability, and of the exhaustion, of soils, and in our knowledge of the action of manures. The sources of external supply of the most important constituents of manure have been vastly developed, and are capable of further development. All these changes point in one direction—in the direction of greater freedom in the cultivation of the soil, and of greater freedom in the sale of its products. Thirty years ago, it was believed that "protection" was necessary to keep up the value of the land of this country. Time has shown how fallacious was that belief. Is it not possible, or even probable, that the fears now entertained that the fertility of our soils, and their rental value, cannot be kept up without the artificial protection of restrictive covenants, may prove to be equally groundless?

DISCUSSION.

Dr. Voelcker, F.R.S., said he had been a frequent visitor from year to year to Rothamsted, and he need not say how deep an interest he had taken in the highly important experiments which had been carried out there for many years, with so much energy and success, and sacrifice of capital and time. These experiments redounded to the glory of England, for there was no other country in the world where anything like the same attempt had been carried out practically, and on so large a scale. He said this from experience, for there was no agricultural station on the Continent of any importance which he had not visited; and to make a comparison

between the results in Germany, France, and other continental countries with those of Rothamsted, he would say that you might put all the others together in one scale, and Mr. Lawes' in the other, and his side of the balance would go down heavily. He felt sure that this paper would make a mark not only on the general community but on all classes of society, for all were interested in the progress of agriculture. The improvement of the soil had a great deal more to do with the welfare of the country than many people supposed. One consequence which he thought would result from this paper, after it had been digested and pondered over by the public, would be greater freedom of cultivation, and this was most important, for it implied the employment of larger capital in farming operations. The chief reason why this was not done was the restrictive covenants which might once have been necessary, and no doubt were useful in former times, but were now somewhat out of date. With a larger expenditure of capital would come a superior class of men; for men could not farm now-a-days as their fathers did, whose operations consisted chiefly in putting in the seed and reaping the crop. Greater intelligence would be required and a strong impulse given to superior agricultural education, and to the raising up of some men of an altogether different calibre from a great many of the small tenantry. When they had a superior class of men cultivating the land this would necessarily affect other social relations. Mr. Lawes had pointed out the great difference between an artificial fertility, or what was called "condition," and permanent, or natural fertility, and this was a subject on which a great deal of misconception existed, more especially on the part of landlords. Many of these were afraid that their tenants would carry off the fertility of the land in the crops they cultivated, and thus by giving them unrestricted freedom of action they would be damaging their own interests. Now, he had long come to the conclusion that it was impossible to deteriorate permanently a naturally productive soil, like many of our soils. On the other hand, it was utterly impossible to increase permanently the fertility of naturally poor soils. What you could do, and thereby affect both the interest of the landlord and the tenant, was to alter the condition of the land. You might let it get out of condition, but he was thoroughly convinced that what was profitable to the occupier was also advantageous to the landlord. What, then, the landlord ought to do was to keep a tenant who was in good condition himself, and knew how to keep his farm in good condition. If he were a landlord, he would not have a bad-conditioned tenant upon his land, but should rejoice in seeing him do well; but he would give him perfect freedom to sell off his straw, or anything he liked, so long as he kept himself in good condition, because in doing so he would keep the land in good condition also; and there would be no difficulty, should he from any cause be obliged to leave, in obtaining another equally good-conditioned man to succeed him, who would, probably, pay even a higher rent. Mr. Lawes had alluded to the fact that certain constituents, although removed in considerable quantities, and from year to year, really did not effect the permanent fertility of the land. For instance, you might exhaust some soils of potass to a considerable extent without making any impression, and a little consideration would show that this must be so. Many soils contained from 1½ to 2 per cent. of available potass, and a still larger quantity locked up in the shape of minerals which only gradually came into play, but the quantity of potass carried off in crops did not exceed two cwt. per acre, if so much. Now ·1 per cent. of any constituent, calculated on a depth of six inches, was equivalent to one ton per acre. Therefore, if a soil contained only ·1 per cent. of the potass, a ton might be carried off from a depth of six inches, but you had not only ·1 per cent, but something like 1½ and upwards in many soils. It was quite true there were other soils from which you could not continually take crops without restoring the potass. It struck him that what they should do was to endeavour to convert cheap materials into more expensive ones—to supply the deficiency of any material, whether potass, phosphoric acid, or nitrogen, in a cheaper form, and convert into produce for which a higher price could be obtained. That seemed to him to be profitable farming. There was a limit to bad farming. A man could not grow on many soils two wheat crops in succession, nor could he do so by merely supplying nitrate of soda, for he would find that the corn went down the second year if he used nitrate of soda only on permanently poor soil. Some might say it was all very well, but Mr. Lawes was an experimental farmer; he was a man of science; but what about the practical man's farm? He was happy to say that he was in a position to point to an instance of a farmer who, even in these late seasons, when so many people had had bad times, had been farming profitably. It might be thought that he had a very good landlord; and his reply was, he had the best landlord possible, for he was his own landlord; and thus you had an illustration that what was profitable to the landlord was also profitable to the tenant. He referred to Mr. Prout, of Sawbridgeworth, who for the last eleven years had followed a course of cropping infinitely more exhaustive than any which could be advocated generally. He had bought some land which would hardly find tenants at 15s. per acre, but at the present time he believed it would let for 42s. to 45s. per acre. During these years he had grown on many of his lands, continuously, corn crops, not without manure, but without farmyard manure, and he kept neither sheep nor cattle. He believed his stock consisted of one milch cow and six horses, and with these six horses and a steam plough he cultivated 700 acres, and sold everything off the land, but when he had a valuation made a short time ago, it showed that he had done extremely well as a landlord. Here was an illustration of intelligent farming, of the great advantage of freedom of action, and of the benefit which resulted to society at large from such an intelligent system of culture.

Mr. J. J. Mechi quite agreed with Professor Voelcker, that the nation at large, and farmers especially, were greatly indebted to Mr. Lawes for his continued information and experiments on improved agriculture. The mode of farming now was very different from what it was 50 or 60 years ago, when all the modern discoveries and appliances connected with agriculture were unknown. The farm then had to keep itself. There were no artificial manures, no guano, no importation of foreign feeding stuffs, no cotton cake, rape cake, or linseed cake; in fact, in those days it became absolutely essential to protect the landlord from the selling of the various crops, which were considered to exhaust the soil, because there were no means of restoring lost fertility. All that was now changed, and he considered leases based on the old system entirely inconsistent with the present improved practice of agriculture. He agreed with those who said that a man could not injure his landlord's land without, at the same time, injuring himself; but still there were people who, either from want of capital or from greed and false economy, would endeavour to sell everything off and bring nothing on; but such a course was one to ruin them as well as the land. The question was—how were they to get additional capital applied to the soil? It could only be done by attracting it. What would our cities have been, if those who conducted business in them were bound by certain fixed rules how they should do so? The principle was the same in agriculture. He would like to ask Mr. Lawes whether, in his opinion, the manure obtained by feeding beasts on cake was not cheaper on the whole, and more effective than artificial manure, allowing for the different outlay of capital? His own opinion was, that provided you understood the management of cattle, which was an important

point, and that you placed them in suitable condition for health, and fed them in a manner consistent with their well-doing, that then the manure so produced, if taken care of and not wasted, would produce greater results than if you depended on artificial manure alone. It seemed absurd, when straw would fetch £4 a ton, and it was only worth 12s. 6d. a ton as manure, so that 1 cwt. of guano would restore the damage done by the removal of the straw, that a farmer should be called upon to sacrifice three-fourths of the price of the produce. Science had done a great deal by showing the value of artificial manures, but it was considered bad farming still to sell roots, though you could sell them for from £1 to 25s. per ton, and their value as manure was little more than 5s. He believed that agriculture in this country was comparatively in its infancy; that the capital applied to it was not more than from £5 10s. to £6 per acre, whereas it ought to be double or triple that amount. With regard to pasture land, it was remarkable that the tenant could not be hound down not to exhaust the farm; for though he was prevented selling the hay, he could sell out the heart of the farm, in the shape of milk and young stock.

Mr. Clare Sewell Read, M.P., could not agree with Dr. Voelcker that Mr. Prout had the best possible landlord in heing his own. His (Mr. Read's) landlady was a good deal better landlord to him than he could be to himself, for he paid her about 3 per cent. for the money she had invested, and although farming was a very had trade at the present moment, on the whole he could employ his capital to greater advantage than by investing it in land at that rate. And he had perfect permission to farm his land as he liked, and he treated it just the same as if it were his own. There was one other point on which he disagreed with Mr. Lawes, viz., when he said that very little outside capital was brought into agriculture, and that, as a rule, it was only farmers' sons who became farmers. In his own particular district, during the last few years, three out of four of the farms which had been let had not been taken by farmers' sons from the district, and though a quarter of the new tenants might be farmers from elsewhere, the other half were gentlemen who had made money in other ways, who were agricultural pupils, and who, perhaps, had more money than they knew what to do with. Coming to the practical part of the paper, he thought the more it was read the more it would be appreciated. He thanked Mr. Lawes for the kind way in which he had spoken of that great Norfolk agriculturist, Mr. Coke, of Holkham, but he would call attention to the fact that his son, the present Lord Leicester, did not insist on all his tenants following the four-course system introduced by his father. His practice was to grant leases for 20 years, and during the first 16 he allowed the tenant to farm as he liked. At the end of that time, unless a renewal was agreed upon, the land was to be brought into the four-course system of husbandry; the only reservation being that, in case he saw during the first 16 years that the tenant was going to the bad, and farming his land in an exhausting way, he should he able to pull him up, and insist on the four-course system being adopted at once. If all landlords would follow his example, a great deal of the agriculture of this country would he improved, and they would not hear of so much agricultural distress as at present; but even in Norfolk the noble example of Lord Leicester was not generally followed. On a great numher of estates the same rigid four course-system was insisted on; and only the other day a relative of his own signed a lease containing exactly the same clauses as his grandfather bad agreed to in 1798. This, of course, was owing to the family lawyer, whom he always pointed to as the greatest enemy of agricultural progress in the present day. He knew a tenant who received six months' notice to quit last Michaelmas, having had a quarrel with the gamekeeper, and he had on the farm a stack of 20 tons of hay. The proposed incoming tenant did not want it, but the landlord would not allow him to sell it, and insisted on its being consumed on the farm, which was almost impossible. Ultimately, he believed, another tenant came forward who took to it, but if this had not happened, what a position he would have been placed in. The hay was worth £6 a ton, and his advice would have been to sell the hay and let the landlord sue him for the damages; and then he should have called Mr. Lawes as a witness, who, he believed, would have told the jury that the loss to the landlord would not have been more than 10s. or 12s. at the most. Only last Christmas he saw a tenant ploughing up a fine layer of sainfoin, which would have produced a much better crop the next year, whereas he could not expect a good yield of wheat from the land; he did so simply because he dare not break through the four-course system. In his own way he had made some experiments on continuous corn-growing; on one field he had grown corn continuously for eight years by the aid of artificial manures, and had succeeded much to his satisfaction. The only two good crops he had this year were a crop of winter oats and one of barley, after wheat, manured pretty freely with nitrate of soda and superphosphate. Mr. Lawes said his land was not much better than the majority, but he would allow him to say to his farming friends that they must be careful how they applied these doctrines to really light and poor soils. Although Rothamsted might not be extraordinarily fertile land, it had the elements of fertility in it, and it had the great advantage of what was termed a coolish bottom. If they applied a continuation of artificial manures to hot, sandy soils, with the idea of producing a mine of wealth, they would find it would impoverish the land and ruin the farmer. Their northern friends would be glad to learn what was the result of Mr. Lawes's barley crop this year; and he believed a great deal of his success was due to the fact that his land was particularly clean. He would also ask him if it was not the fact that though hy constant weeding he had attained this result, he every now and then found a quantity of wild oats coming up. People thought that wild oats were things that passed away in one's youth, and that the land would soon become exhausted of such pernicious weeds, but it was a singular fact that, notwithstanding all you could do, there were certain soils which would produce a continuous crop of certain weeds, however well you might till them. He could not sit down without expressing his deep gratitude to Mr. Lawes, not only for his present valuahle paper, but for his long continued and most valuable experiments. He was glad to hear what Dr. Voelcker had said, and to find that with all the State patronage abroad, a country gentleman in England, with capital and energy, had had the pluck to go through with these experiments for over 30 years, experiments which completely threw everything else of the kind into the shade. He believed Mr. Lawes would be glad to see even more visitors at Rothamsted, and he could assure his friends there was no pleasanter or more profitable way of spending a holiday.

Mr. Wm. Botly was glad to find that Mr. Lawes had corroborated some points which he (Mr. Botly) had hrought forward in a paper he had read before the British Association at Edinburgh. The main point he there insisted on was the necessity for security of tenure, and compensation for unexhausted improvements, and if this could be secured, he felt sure it would benefit hoth the farmers and the country at large, financially and politically. This was illustrated by the fact mentioned in the paper, that there was a large quantity of nitrate of soda lying at the docks which could not find a purchaser. To improve agriculture you must have more capital, skill, and enterprise invested in it, and this could only be obtained by conceding tenant-right.

Mr. James Stratton, as a tenant-farmer, desired to express his gratitude to Mr. Lawes, from whose experiments he had learned almost everything which had been profitable to him. As to consuming straw by bullocks,

and so on, nobody in his senses would do it, if he were allowed to sell the straw. He did last year, for a fancy, fatten out 50 fine bullocks, and this was the result:—They were put into the stall worth £14 each, and they came out in April worth £20, but the £6 profit just paid for their keep in corn. The straw which they had consumed he could have sold for £300, and the manure which they made covered just 33 acres, so that the manure cost £10 per acre. This, therefore, was a suicidal policy which he should never follow again. They were in an open farm-yard. Mr. Mechi had remarked, that the pasture farmers exhausted their land by selling off cheese and bone, but he could not agree with the idea. He had been a farmer on pasture to the extent of more than a £1,000 a year, and he could point to pasture which had been farmed in that way from time immemorial, and now let at £4 per acre. If it had been subjected to this exhaustive process for 400 or 500 years, what must the land have been worth originally. The crops at Rothamsted were better than he had ever seen them, and as to the idea that farmers would not pay attention to the results because they were experiments, he thought it almost an insult to their common sense. They must see that Mr. Lawes' experiments on a few acres were a fair index of what might be done on hundreds of acres. He would not speak of his own experience further than to say that he farmed not quite 3,000 acres, and he had copied Mr. Lawes for a great many years with complete satisfaction.

The Chairman said he was that evening occupying a place which should have been filled by someone having more knowledge of agriculture than himself. He was a man of business, and had been all his life, and he could fully understand the doctrine which was now prevalent among farmers, that their interest was to produce the greatest possible quantity from the land which they cultivated. And undoubtedly that was the interest of the great mass of the people in this country, who, whilst maintaining free trade in every possible way, desired to produce as much as possible from the land given to them for use, and which they could not increase. Therefore, when they found so many gentlemen connected with the land advocating freedom in the mode of cultivation, and an entire abolition of unnecessary restrictions, it appeared to him that they were rapidly following the commercial classes into the region of free trade, and if they did so to the end there could be no doubt the result would be advantageous both to the nation and to themselves. He thought Mr. Read had been rather too hard on the family lawyers, however, because there were many lawyers who had the control of property in the city of London who could not be called family lawyers, but who showed quite as much intolerance in the granting of leases as the most old-fashioned family lawyer in the kingdom. He concluded by moving a cordial vote of thanks to Mr. Lawes.

The motion having been carried unanimously,

Mr. Lawes said he had but little to do beyond thanking the meeting for the kind manner in which it had listened to his remarks. Mr. Mechi had asked whether keeping stock was not more profitable than buying artificial manures. His view was that there was stock land and corn land. Where you had good stock land, there could be no cheaper mode of making manure than by feeding stock liberally; but there was a great deal of corn land not at all adapted to stock, and the less you had on it, except in summer, the better. These lands had great resources in themselves, and there was no reason why they should not be utilised. When you made manure out of cattle food, you applied to the land a great many things which it did not want; but when you applied artificial manure, you only used those things in which the land was deficient, and took out that which it would provide you for nothing. Some day, when there was a sufficiently large audience who were at liberty to deal with it, he should like to discuss this question of what was the most economical mode of farming. He did not say that everyone was to grow as much corn as they could; they would soon come to the end of that by producing wild oats, or some other of those pests which could only be got rid of by some other course of cropping. Although he had grown a great deal of corn, it was rather to find out how to grow it than to induce everyone to follow him and grow corn for ever. It would require a long evening to properly discuss this question, and the character of the soil, climate, and a variety of circumstances would have to be considered. With regard to barley, he had stated that he had had 25 crops one after the other with nitrogen, either as ammonia or nitrate of soda, but without potass, and that by the use of potass they had produced practically no better result. This year, for the first time, the potass had failed a little and they had now produced about 10 or 12 bushels more per acre with potass than without, showing that they were coming to the end of the potass in the soil. This year they had obtained 54 bushels of straw and corn with potass, and 42 without it. Of course this was to be expected, and they had expected it much sooner. The same with wheat; he expected the end would come in a few years, but they had now gone on between 30 and 40 years. When the end came they would not be sorry, because then they would have the knowledge they were seeking for.

Mr. C. S. Read asked what were the manures used besides potass which produced the 54 bushel crop?

Mr. Lawes said phosphoric acid and nitrate of soda. With nitrate of soda alone they produced 35 bushels, and the land had had no potass applied to it for 55 years.

MISCELLANEOUS.

HEALTH.*

By Edwin Chadwick, C.B.

It will be my duty to submit to you, as well as I may, from my own point of view, the present position of sanitary science, for its future practical advancement.

A Stationary Death-rate, with a Largely Increased Population, is really a Reduced Death-rate.

It has been recently put forward by a gentleman who held this chair at Liverpool, that notwithstanding all the expense incurred by local authorities for sanitary works, there has been little alteration in the death-rate during the last forty years. In great part this is true, and I may show why it is so; but the figures are misleading, for with an increase of the population during that period, from about fifteen to twenty-two millions, with extensive conditions of overcrowding of the dwellings of the wage classes, and of cottages which formerly served for one family, but which have now frequently one family to each room, there have been augmentations of death-rates at many points, insufficiently counterbalanced by reductions at others. It will be found that a stationary death-rate is, relatively to a largely increased population, a reduced death-rate. But the statement is, as I shall show, so couched as unjustly to depreciate our increased power of sanitation. Then we have had the doctrines of Malthus raised against us, and it is held forth that by increasing the population we shall by division diminish its subsistence fund and intensify misery. Those doctrines were pressed for application when the population was one-third what it now is. They were again

* Opening Address to the Health Section of the Social Science Congress.

pressed as of increasing necessity, when it was one-half what it now is. In what comparative condition of comfort would the population now be, and in what prosperity and strength would the nation be, if it were now as it then was? In my service in Poor-law administration, I had to deal practically with those doctrines. In one county we at once struck off 10,000 able-bodied men from the pauper-roll of out-door relief in aid of wages. The Malthusians declared that wages must be reduced by that measure, and that its working must be horrible. But lo! wages, instead of falling, rose higher than they had ever been before. In the very county where the objection was raised the population has been increased during the last half century from half a million to upwards of two millions, wages have been doubled, and —until the late check to manufactures and population—productive population had become scarce, as I foretold it would be. I might add that, if by sanitation the population were increased to the extent foretold, why then, as it is estimated that of the habitable parts of the globe only one-sixth is really believed to be inhabited, we shall have sufficient outlets for the superabundance of a strengthened population. Noting the fact that at the period of the promulgation of the population doctrine, epidemic visitations were regarded as "positive checks," absolutely unpreventable and uncontrollable,—I beg attention to the progress made in the development of the powers of sanitation in absolute prevention; especially as bearing on those visitations. In our first meeting in Birmingham, in 1857, Lord Stanley, now the Earl of Derby, referred to my official Report of 1842, on the sanitary condition of the labouring population, in terms with which subsequent dedications to me of works on the subject—of which I prize most the dedications by officers who have served with me—have concurred, in accepting that Report as the starting point of public effort in sanitation. I therefore propose to submit examples of the development of those powers since that period. Our general death registration is defective in itself, and it is yet more defective for our present purpose, because in the same registration districts houses situate outside sanitary works which have had no amendment are mixed up with others in areas which have been so amended, and it is hence very difficult to obtain distinct and just conclusions in respect to the results of such works. We may, however, see more clearly the operation of principles, and obtain more satisfactory conclusions, by observing their working on similar classes of persons in similar conditions, as in the army and the navy; or in public institutions under distinct professional observation and care. It is to such instances that I beg to solicit attention. And first, as to the prevention of the greatest sources of preventable diseases, "the children's diseases" and "children's epidemics."

A Norma of Sanitation for the Infantile Stages of Life.

In 1838, there fell to the direct administration of our Poor-law Board, of which I was the secretary, two large institutions for the care of destitute orphan children, which suffered severely from passing epidemics or typhus fever. In one, at Norwood, containing 700 children, there was a severe outburst of typhus fever, by which more than a third were attacked, and more than 30 were killed. The general declaration of medical men at the time was, that the mortality was occasioned by deficient food. But the food was better and more abundant than the food of the independent wage classes. I got the case examined by the late Dr. Neil Arnott, who was a specialist in one element of sanitation—ventilation. He pronounced the main evil to be, not deficiency of food, but deficiency of pure air, and that the remedy was the constant removal of putrifying matter by good drainage, and of foul air by ventilation. This was adopted, with the result of a reduction of the death-rate by about one-third. Next followed the production of clean skins, by regular head to foot ablutions with tepid water*; and this was followed by the reduction by about another third of the ordinary death-rates. Other improvements in detail have followed, chiefly in physical training. As sanitary improvement has advanced in these institutions, there have been fewer inmates of the sick wards, to the extent that not a fourth of the beds provided for sickness are now usually occupied. The particular institution first attacked, and now eight other large orphan institutions, district asylums, are, in fact, children's hospitals, where numbers are received only to die. All the inmates, as a class, are of the most wretched type of children, all weakly and susceptible to disease; but of those who come in without marked disease, there is now an almost absolute immunity from the "children's epidemics." Cases of typhus, at one time scarcely ever absent, have not been seen there for several years. The mean death-rates in these institutions have been steadily reduced to about 3 in 1,000, that is to say, to nearly one-fourth of the general death-rate of children of the school ages, including the children of the well-to-do classes of the population. It was recently stated, as evidencing the success of the "boarding out" system, that the deaths had not exceeded 2 per cent.; and this, probably, may be taken as an average children's death-rate for the cottage;—that is to say 20 per 1,000, as against 3 per 1,000 in the district orphan institutions, with little variation in the separate institutions. Medical officers in charge of them, but who are in private practice, have repeatedly expressed to me their astonishment at these results of sanitation as surprising and wonderful to them. I was lately present at a prize-giving to agricultural labourers by Lord Shaftesbury, where one prizeman was a shepherd who, out of 100 lambs he had reared, had only lost one. Such emulation may well be directed to the preservation of human life. On a visit to one of these orphan institutions, I told the governess of the infants that the Queen of the Belgians had offered a gold medal to whichever manager of such institutions should rear the greatest number of infants, and I asked the governess whether she would compete in conservancy of life against that shepherd with his lambs. She proudly declared that she would do more than that, and with the infants of the ages under her care she really has done more. It is, however, to be noted that the schools are on the half-time principle, which we introduced with the Factory Acts, as preventive of the physical injury done by over-sedentary work in the long-time schools; and I may add that by a better adjustment of the book teaching to the children's mental powers of receptivity, and by the "freshening up" of the faculties by brisk gymnastic exercises and military drill, these children, though naturally of an inferior type, are got well through the R's in less than four years, as against seven in the common elementary schools, and at half their cost for teaching power; and with the economical outcome, that the efficiency of three is imparted to two for industrial occupations. Formerly, very much from bodily inaptitude, not one out of three got good places; now a very small per-centage fail to do. Here, then, we have a great sanitary norma established with factors that go to the prevention of an annual excess of upwards of 50,000 deaths in the school stages of life, in England and Wales.

A Norma of Sanitation in Adult Stages of Life.

I would now call attention to another norma of sanitation, for adult stages of the population.

It has fallen to my lot, in the course of my early service, to examine and compare the results of sanitation in our prisons. Prisons, I need not remind you, were, in the time of Howard, seats of the reputed special "gaol fever," to which not only prisoners, but juries and judges

* On skin cleanliness generally, as a factor in sanitation, see an exposition of mine made for the Congress on Domestic Economy, held at Birmingham, and published, with other papers, by the Society of Arts.

who tried them, have heretofore fallen victims. But now, by clean air, clean persons, pure water, and by regulated regimen, prisons are made seats of health, and display the most conspicuous norma, to be kept in view of the power of sanitation in adult life. Sir Robert Christison, the distinguished consulting physician on the prisons of Scotland, declares that the general prison of Scotland, that of Perth, is apparently the most healthy place in the world. He states to me:—"The healthiness of the general prison is almost marvellous. I have, down to the present time, inspected it as Government inspector six times annually for thirteen years past, and have very seldom indeed found more than one man and one woman in bed amongst 750 prisoners—once or twice no one!" In the common condition previously from such a number of prisoners, a large sick ward would be occupied. He is most emphatic in his expressions of astonishment at the result. I have heard similar expressions from prison surgeons in England, and that they are wont to say of patients in their private practice, "Oh, if I could only have that case in prison, I could save tho life." It may be said that the epidemics which ravage the populations under the rule of Baily bodies, vestries, and the like, do not now touch the populations in the prisons under the care of the State. Epidemics rage around them, but do not enter them, unless it be by some extraordinary accident, or some very culpable negligence.

I once met a prison surgeon of our Model Prison at Pentonville, who appeared to be in trouble of mind. I asked him if anything had happened? He had got a case of small-pox in the prison! The disease was then ravaging the courts and alleys in the vicinity of the prison, where as many as a third of the wage classes in some of them were attacked. But this by no means consoled him; a case had no business to be in his prison. A case of cholera occurred in one of the Scotch prisons, and there was a serious consultation about it, and an elaborate speculative report as to how such an extraordinary event could have occurred there. We heard at the Board of Health that there was an attack of dysentery in a prison, and on hearing of it we were perfectly certain that there was misfeasance or culpability somewhere. On inquiry it turned out that an ill-constructed prison drain had burst into the prison well, from which the prisoners were supplied with drinking water. In the Milbank Prison cases of typhoid fever were at one time frequent, and were traced to sewer-tainted water from the Thames. For the protection of the prison population, this source of supply to a large proportion of the outside population, was stopped, and spring sources, such as we recommended for the metropolis, were resorted to, with the result that typhoid fever, which continued to prevail amongst the general population of the metropolis, has been long extinguished amongst the population of the prison. In another prison an outbreak of typhoid fever took place, which was found to have arisen from the overflow pipes being connected direct with the main sewer, which conveyed the gas from the sewer to the prison water tank, so that those gases were absorbed by the water which the prisoners drank. This connection was severed, and the prisoners were restored to their superior health. But, in the metropolis and other larger cities, from the work of ignorant plumbers, to whom is left the uncontrolled internal distribution of water, the like connections are made by waste or overflow pipes opening into the common sewers, whence the sewer-gases of ill-constructed sewers of deposit and consequent putridity are led into the cisterns of the houses under vestry rule,—with the continued consequences to the general population from which the population under State sanitary rule are protected. Temperance, or the enforced exclusion from alcoholic drinks (as well as from tobacco) may, it is observed, have claims as factors in the great sanitary results, but to what extent the prison surgeons I have consulted cannot determine, for they have observed similarly good results manifested in the health of female prisoners who have not been gin or beer drinkers, but chiefly tea drinkers.

To prisons, then, we should accustom the health authorities to look as strongholds of attained and attainable sanitation. About two-thirds of the prisoners, as appears in Scotland, enter the prisons with disease upon them, often in advanced stages. Eliminating these cases, we may get a measure of progress from the military prisoners whose death-rates as outsiders we know. Men have been taken from the ranks, where the death-rates were 17 in 1,000, and put into the prisons where the death-rates were only 3 in 1,000. I am led to consider, from various evidences, that a death-rate of 3 in 1,000 may be taken as an attained normal death-rate for the adult stages of the life of the ages of the prison populations.

Here, then, we have two great sanitary normas—one of a death-rate of a little more than a fourth of the common death-rate in the infantile and juvenile stages of life, and the other of the like proportion in the adult stages. These results of sanitation in the exemptions from ordinary as well as extraordinary epidemics, excite the astonishment of the professors of the curative service. Yet these results are obtained by very rudimentary means applied, especially in the juvenile stages, by agencies for which high refinement cannot be claimed. On examining these same results it is evident that they are yet susceptible of further advances. Undivided professional attention (which is frustrated by the administrative arrangement which necessitates anxious attention to private practice), and close observation of the comparative experience of several of such establishments, would evolve important contributions to sanitary science. Thus, the effects of sanitation, under different conditions of climate, have yet to be observed and discriminated. In one children's institution at Calcutta, similar to those instances cited near the metropolis, a death-rate of about 7 in 1,000—not of a fourth, but of one-half the ordinary death-rate here—has been obtained, which gives good promise of the practicability of rearing children Indian-born of British residents, and so establishing succession in our Indian dominions.

Different Species of Disease, attendant on Different Doses of Aerial Impurity.

I obtained observations of one large prison, that of the French prisoners of war in this country, who were confined on the high and fine site for air, the granite of Dartmoor. As the number of prisoners, and the crowding of the prison was increased, and in the then ignorance of the principles and means of sanitation, typhus became rife and dreadfully predominant. As the numbers of the prisoners were reduced by exchanges, typhus was reduced, and finally disappeared; yet phthisis remained, and was prominent, but when the number of prisoners was still further reduced, phthisis was reduced, and on the prison being further thinned finally disappeared. The apparent immunity from phthisis amongst the reduced numbers of the prisoners attracted the attention of a physician who was a very good observer (the father of the late Dr. Hunt), who applied the fact successfully in his practice. He was wont to send patients who were smitten with consumption up to Dartmoor, and to provide that they should be kept alone in rooms carefully aërated. Cases occurred of whole families in lower sites smitten with phthisis, of whom he could persuade only one to take the remedy of pure aëration, and that one recovered, whilst the rest who remained fell one after another. This great prison presented an example on a large scale of the deterioration of the finest air and water by insanitary treatment; and, moreover, of another important subject needing further observation—the production of different orders of disease in the same air, by different doses of aërial impurity on the sites and under the same atmospheric conditions.

(To be continued).

CORRESPONDENCE.

LIGHTNING CONDUCTORS.

In reference to a letter addressed by me in the *Times* on this subject, and reprinted in the *Journal of the Society of Arts* on December 7, at page 39, will you find me further room to say that the modification of opinion to which you have kindly drawn attention by a foot-note, relates more pointedly to the straining produced in copper ropes by their process of manufacture than to their relative conducting power, when this is compared with solid copper rods, or tapes. All that I intend at present to say is, that I think I have hitherto somewhat too hastily assumed that copper wire ropes are proved to be molecularly injured by twisting in manufacture. I have recently learned, what I was not aware of some few months since, that Mr. Newall professes to manufacture his ropes without strain from twist; and I have every reason, from his great skill as a manufacturer, to believe that whatever he professes he efficiently does.

I am not, however, yet prepared to say that ropes formed of small wires do not offer a somewhat larger resistance to transmission of electric force than solid rods, or tapes, of the same weight of metal per foot. That is an altogether different point, and one which I think yet requires further experimental investigation. It is, nevertheless, unquestionably true that well manufactured copper ropes of sufficient dimensions, do furnish altogether efficient protection against damage by lightning. You will at once perceive the bearing which this explanation has upon the foot-note which you were so good as to append to your reprint. The asterisk should have been after "Process of Manufacture,*" and not after "Dimensions.*"

I should be glad also if you will allow me to say that the letter to the *Times*, which you have reprinted, expresses my own views of the matters of which it treats, rather than any formal decision of our Lightning-rod Committee, which has not yet matured its deliberations upon the requirements of lightning conductors, or authorised the issue of any specific instructions concerning them. I quite inadvertently dated my letter from the rooms of the Meteorological Society, rather than from my own residence; and this, without further notice, might possibly convey an impression in this particular which I did not intend to give.

Robert James Mann, M.D., &c.

Wandsworth-common, December 8th, 1877.

NOTICES.

Ordinary Meetings.

Wednesday Evenings, at Eight o'clock. The following are the arrangements for the last Meeting previous to Christmas:—

December 19.—"The Telephone," by Prof. A. G. Bell. Repetition of the former discourse. Lord Alfred S. Churchill will preside. The meeting will be held at the Freemasons' Tavern.

Cantor Lectures.

Monday Evenings, at Eight o'clock. First Course, on "The Manufacture of Paper," Six Lectures by William Arnot, Esq., F.C.S.

Lecture IV.—December 17th.

Paper made by hand and by machinery. The Fourdrinier machine. Surface sizing. Drying machinery. Finishing.

Lecture V.—January 14th.

The Chemicals used in the paper mill; their nature, economical use, and methods of valuation. The recovery and re-use of soda as an economical process and in its sanitary bearings. The disposal of washing and machine waters, so as to minimise the pollution of streams.

Lecture VI.—January 21st.

The various classes of Paper; characteristic differences. The determination of the ash or loading. Water supply. General arrangement and construction of the mill.

Juvenile Lectures.

A short Course of Two Lectures, suitable for a juvenile audience, will be delivered during the Christmas holidays, by Prof. Barff, M.A., on "Coal and its Components." Special tickets will be issued for these lectures.

MEETINGS FOR THE ENSUING WEEK.

Mon.... **SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. W. Arnot, "Manufacture of Paper." (Lecture IV.)
British Architects, 9, Conduit-street, W., 8 p.m. Mr. Locock Webb, "The Law of Easements."
Medical, 11, Chandos-street, W., 8 30 p.m.
Asiatic, 22, Albemarle-street, W., 3 p.m.
Victoria Institute, 10, Adelphi-terrace, W.C., 8 p.m.
London Institution, Finsbury-circus, E.C., 5 p.m. Prof. T. H. Huxley, "The Extinct Animals termed Belemnites, and their Ancient and Modern Allies"

Tues.... Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Annual General Meeting.
Statistical, Somerset-house-terrace, Strand, W.C., 7¾ p.m. Mr. Ernest Seyd, "Diagrams exhibiting the Position of the Banks of England, France, Germany, Austria, the Netherlands, Belgium, Italy, and Russia."
Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Wed.... **SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Prof. A. Graham Bell, "The Telephone." (Meeting will be held at Freemasons' Tavern, Great Queen-street).
Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Commander Edwin Bourke, R.N., "Notes on the Meteorology and Physical Geography of the West Coast of Africa, from Cape Verd to the Cape of Good Hope." 2. Prof. H. Mohn, "The Meteorological Observations made by the Norwegian Research Expedition in the North Atlantic in the Summers of 1876 and 1877." 3. Rev. T. A. Preston, "Report on the Phenological Observations during 1877."
Geological, Burlington House, W., 8 p.m.
Royal Society of Literature, 4, St. Martin's-place, W.C. 8 p.m. Mr. Walter De Gray Birch, "An Unpublished Saxon Charter lately restored to the Library of Worcester Cathedral."

Thur.... Royal, Burlington House, W., 8½ p.m.
Linnean, Burlington House, W., 8 p.m. 1. Mr. Thomas Meehan, "The Laws Governing the Production of Seed in *Wistoria Sinensis*" 2. Prof. A. Nicholson and Dr. J. Murie, "The minute structure of *Stromatopora* and its allies." 3. Mr. Worthington G. Smith, "Remarks on a Fossil *Peronospora* with Zoospores *in situ*." 4. Prof. M. Watson and Dr. A. H. Young, "The Anatomy of the Elk (*Alces machlis*). 5. Prof. Dickie, "Algae of the Arctic Expedition." 6. Dr. J. S. Baly, "Phytophagous Coleoptera."
Chemical, Burlington House, W., 8 p.m. 1. Dr. Armstrong, "The Constitution of the Terpenes and of Camphor." 2. Dr. Armstrong, "Communications from the Laboratory of the London Institution." 3. Dr. Silden, "Hydrocarbons obtained from Pinus Sylvestris, with some remarks on the Constitution of the Terpenes." 4. Mr. Y. W. Thomas, "Cuprous Chloride and the Absorption of Carbonic Oxide and Hydrochloric Acid." 5. Mr. F. Jones, "The Action of Reducing Agents on Potassium Permanganate." 6. Dr. Wright and Mr. Paterson, "Citric Acid as a Constituent of Unripe Mulberry Juice."
London Institution, Finsbury-circus, E.C., 7 p.m. Mr. W. A. Barret, "Sir Henry Bishop." Illustrated Musical Lecture.
Numismatic, 4, St. Martin's-place, W.C. 7 p.m.
Mathematical, 22, Albemarle-street, W., 8 p.m.

Fri....... Volunteer Sick Bearers' Association (at the House of the Society of Arts), 7 p.m.
Philological, University College, W.C., 8 p.m. Mr. J. A. H. Murray, "Some Doubtful Points and Practical Difficulties in English Grammar."

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,309. Vol. XXVI.

FRIDAY, DECEMBER 21, 1877.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

JUVENILE LECTURES.

A course of two Lectures, adapted for a juvenile audience, on "Coal and its Components," will be delivered by Prof. Barff, on Wednesday, January 2nd, and Wednesday, January 9th, at seven o'clock. As the number of seats is limited, admission will be by ticket only, and when sufficient tickets have been issued to fill the Room, the issue will be discontinued. The tickets will be supplied strictly in the order in which the applications are received. Subject to these conditions, each member is entitled to a ticket admitting two children and one adult. Tickets can now be obtained by members on application to the Secretary.

INSTITUTIONS.

The following Institution has been received into Union since the last announcement:—

Young Men's Christian Association, St. Helen's, Lancashire.

FIFTH ORDINARY MEETING.

Wednesday, December 19th, 1877; Lord Alfred S. Churchill, Vice-President of the Society, in the chair.

The meeting was held in the Large Room of the "Freemasons' Tavern," and, though the room holds over a thousand persons, it was crowded half an hour before the lecture began. So far as can be ascertained, it appears that over 1,200 persons were actually present, and large numbers left without even attempting to enter the building. As Prof. Bell's lecture was in the main a repetition of that which he delivered on the 28th November, it has not been considered desirable to repeat the report of it, which appeared in the *Journal* of November 30. A number of additional diagrams were, however, shown, illustrating the inventions of Reuss, Elisha Gray, and others, and the arrangements for multiple telegraphy employed by Prof. Bell.

The following candidates were proposed for election as members of the Society:—

Ahrbecker, H. C., 117, Stamford-street, S.E.
Bennett, Dr. W. C., Hyde-cottage, Greenwich.
Bishop, Charles Kenwrick Kenelm, 18, Provost-road, Haverstock-hill, N.W.
Bray, Henry A., M.D., Queen-street, Market Rasen, Lincolnshire.
Cooke, Charles Wallwyn Radcliffe, 3, Essex-court, Temple, E.C., and 6, Cambridge-gardens, Notting-hill, W.
Goode, William, Thorn-lodge, Mulgrave-road, Sutton, Surrey.
Marshall, John, F.R.G.S., Auckland-lodge, Queen's-road, Richmond, Surrey.

The following candidates were balloted for and duly elected members of the Society:—

Brown, John, Claremont-villa, Falcon-road, Battersea, S.W.
De Roux, William, Consul for Portugal and Brazil, Panama.
Laing, Robert James, The Limes, Upper Clapton, E.
Leary, Thomas George, 48, Avondale-square, Old Kent-road, S.E.
Mayers, William Henry, Clevedon-lodge, Thurlow-park-road, West Dulwich, S E.
Salkeld, Lieut.-Col. Joseph Carleton, 29, St. James's-street, S.W.
Sennett, Alfred Richard, 109, Clapham-road, S.W.

CANTOR LECTURES.

THE TECHNOLOGY OF THE PAPER TRADE.

Lecture I.

Introductory, Historical, Descriptive, and Statistical.

The absence of authentic records has been the cause of much speculation as to when, where, and by whom paper was first made. The Chinese people have, however, generally been credited with its discovery, and there is little room to question their claim. We find that this peculiar people have in many of the arts been at work and made discoveries centuries before us. The state of perfection to which they have brought the manufacture of paper, in the absence of the elaborate machinery with which we are familiar in the modern process of paper-making, is something marvellous, and the great variety of purposes to which it is applied by them is not less wonderful. Articles of furniture and clothing, and many other useful appliances, are made from this material by this industrious, though curious people. We do not purpose to go into the history of the writing materials in use prior to the discovery of the process of paper-making. It may be necessary, however, to state that all the tablets, leaves, and parchments in use in remote ages were natural productions, whereas paper properly so-called is eminently artificial. The tablets of stone and of wood, the leaves of the papyrus, the bark of the mulberry and other trees, the skins and other portions of animals, although prepared for this special purpose by various processes, were all strictly natural products and could not in any case be regarded as artificial.

Paper, taking the description given by a recent writer, is an aqueous deposit of any vegetable fibre, radically different in its structure from all

bodies formerly used for writing upon, being a highly artificial material and having no resemblance in its texture to any natural substance. It is probable that paper, bearing an essential resemblance to this description, was made about the seventh century. One writer mentions a date 700 years prior to this, about the beginning of the Christian era, but the earliest reliable accounts we have regarding the material date from the beginning of the 10th century. About the beginning of the 14th century we have fuller accounts of the process, which, by that time, had no doubt developed considerably. A century later we find paper mills at work in England, under royal patronage, while in Scotland, where the trade now flourishes, it was not till towards the end of the 17th century that the first mill was established.

The early history of the process of paper-making is, no doubt, interesting, but the records regarding it are so meagre and conflicting that we fear the practical end which these lectures are intended to serve would be but little advanced by even the most elaborate historical disquisition. That being the case, we shall only consider the history of the art in its more recent developments, so far as is necessary to enable us to appreciate the ingenuity and beauty of the processes at present in use.

Until 1860, although many fibrous materials had previously been experimented upon, rags of various kinds may be said to have been exclusively used for the production of paper pulp. In that year, however, esparto grass clearly established its claim as a practical and abundant source of fibre. Since then its use has been very largely extended, and at present much more paper is produced from it than from rags. For the finer and stronger classes of paper, however, rags are still used, either by themselves, or mixed with esparto, and it is probable they will always hold the foremost place, both on account of the strength of their fibre, and the per-centage yield. This last feature of rags is of course due to the circumstances that almost all the extraneous matters originally associated with the fibre, have been removed by the processes to which the raw materials were subjected, when being prepared for their first manufacture into linen and cotton goods.

The process of reducing rags to the condition of pulp was, up to the middle of the last century, most tedious and laborious. The chemicals which now play so important a part in the process of paper-making had no place in the paper-mill, indeed bleaching powder was yet to be discovered, while caustic soda was only known as a chemical curiosity. The rags were first cut and sorted, then soaked with water, and put aside in heaps to ferment or rot. In this condition they lay for from five or six days to as many weeks, being turned at intervals to prevent over heating, and also to secure a uniform result. No doubt the action which developed in these rag heaps was a species of fermentation, during which the glutinous matters inherent in them were changed in their nature, and made more easy of removal in the after stages of the operation. If care had not been exercised, and had this process been allowed to go on after the gluten and fat had been destroyed, the cellulose or fibre would undoubtedly have shared the same fate; a certain degree of skill was, therefore, necessary to the proper carrying on of this process, crude though it may seem.

A copious washing followed the rotting process, as it was called, after which the process of pulping was conducted in the following manner:—The implement employed may be regarded as a species of mortar with a tight-fitting pestle or stamper working in it. The mortars were constructed of stone, or wood, and the stampers were moved by levers actuated by projections fixed on the water-wheel shaft. A charge of rags for one of those mortars was about 3 lbs., and it took about twenty-four hours to complete the operation. Under this process there was no cutting or tearing, consequently the fibres were long, and the paper so produced was of great strength. To keep one of the largest of our modern paper-making machines at work no fewer than five thousand of these mortars would be required.

The pulp having been thus prepared was diffused through a large quantity of water in a vat, and kept uniform by agitation. From the vat the pulp was lifted on a series of moulds, each of which represented a sheet of paper of some definite size, duly christened with some antique name, such as "Antiquarian," "Double elephant," "Foolscap," and so on. By a dexterous shake, the fibre was caused to settle down uniformly, and closely interlaced over the entire surface of the mould, while the water passed through the interstices of the wire cloth, of which the mould was constructed.

From the mould the paper, which may be said to have been now formed, was placed between layers of felt, pressed by means of a hand screw press, so as to remove as much of the moisture as possible; then removed from the felts, and pressed again; and finally, it was dried, sized, and calendered. The hand process, as at present conducted, will be more fully explained and illustrated as we proceed.

The simple mortar and stamper, already described, seem to have been improved upon previous to the introduction of the beating engine, to which we are about to refer. Metal plates, with some sort of teeth, were introduced, and two stampers, rising and falling alternately, instead of one; so that the operation was more rapid and uniform, and a certain amount of cutting, or tearing, effected. The rags, too, seem to have been rotted in chests, or cases, which was, no doubt, a refinement; but it does not appear that any important improvement resulted from this addition to the plant of the paper mill.

About the middle of the last century a great stride was made, when the beating-engine was invented. It is to Holland we are indebted for this important improvement, and by the name of the "Hollander" the engine was long known. Although tons could be pulped by this machine, as compared with cwts. by the old method, a considerable period elapsed before it was fairly accepted by the papermakers.

The beating-engine may be briefly described as an oblong tube or cistern, with a partition running along the centre lengthwise, to regulate the flow of the stuff. At one side of the partition, at the bottom, is fixed a set of knives, with the edges looking upwards, while over these revolves a drum or roller, in which a second series of knives are fixed. Between the two sets of knives the rags, which are immersed in the water which fills the engine, are drawn, and, as the roller revolves

rapidly, the cutting and tearing action is great, and disintegration speedily effected.

About fifty years after the invention of the "Hollander," alkali began to be employed for boiling the rags, and the rotting process was entirely superseded. Commercial caustic soda, which is now so extensively employed, was not known till long after this time, so that caustic lime (lime shell) was used either by itself, or along with carbonated alkali, which it, of course, causticised. At first both the agents were put into the boiler with the rags, but in course of time a great refinement was effected; the caustic soda liquor being prepared in a separate vessel, the lime allowed to deposit, and the clear liquor alone run into the boiler.

Boiling seems to have been practised to some extent previous to the introduction of chemical agents, this being done in open cauldrons with direct fire heat. But the rags suffered in this process, those in immediate contact with the boiler getting burnt or singed. To obviate this, steam was ultimately introduced, first by a simple pipe or coil, and afterwards by what are called vomiting tubes. Little or no pressure was at first put upon the boilers—indeed, from their construction, they could not stand much pressure—but we find in recent times many boilers working under a pressure of 30, 40, and even 60 lbs. per square inch.

Almost simultaneously with the introduction of soda, which in after years made the use of many other fibrous materials besides rags possible, artificial bleaching agents began to be introduced. At first chlorine in its gaseous and simplest form was used; but this was dangerous and troublesome in its application, and expensive in production, and ere long it gave place to the admirable invention of bleaching powder.

Paper beautifully uniform in texture, and as white as snow, was now not only possible, but easy of attainment. Still, however, the production was limited, each sheet having to be made by itself. Machinery had revolutionised one department of the process, and made the production of pulp easy and rapid; the disintegrating part of the work was now nearly perfect, but the building up of the fabric was slow and laborious, the nimble fingers of the Fourdrinier machine not having yet begun to weave the delicate fabric.

In 1799 the dawn of a second revolution appeared, when Louis Robert exhibited his model of a machine calculated to make paper in a continuous web. The germ of this invention was, like those of most other great discoveries in mechanics, developed in the midst of many difficulties, and its growth into the perfect piece of mechanism which it is to-day, was slow and laboured. Unhappily, too, for the credit of many parties concerned, the men whom we have most to thank for this wonder worker, which is so manifestly blessing the whole race of mankind, were allowed to share the fate of many other great inventors. The Messrs. Fourdrinier, and their ingenious engineer, Donkin, deserved well at the hands of their country, but more especially so at the hands of the paper manufacturers, who were reaping the immediate advantage of their labours. Sad it is to think that the fruit of all their labours to them was a loss of £60,000, hopes scattered to the wind, and their whole lives embittered.

Before the introduction of the Fourdrinier machine, many minds had been at work, fully realising the advantages to be derived from a speedier method of converting the pulp, now so easy of production, into paper. One of the most successful attempts at doing this by machinery was undoubtedly in the machine patented by Mr. Robert Cameron, of Springfield, near Edinburgh. But although this machine worked fairly well, it was after all only a machine for making hand-made paper, that is, the paper was made in sheets, and not in a continuous web. Indeed, this fact earned for the machine the nickname of the "Wooden Man." The following is a description of it, abridged from a paper by Mr. George Bertram, and it will explain what is meant by saying it was only a machine for making hand-made paper:—

"The machine contained ten moulds in all, each being mounted on a square-shaped frame or carriage, having four small wheels, for the purpose of moving round the machine, which was of an elliptical form, or as we might more appropriately term it, a model of an endless oval railway. The motion given to the mould frames was by means of a pitch chain, made to revolve on a chain wheel placed at each end, and in the focus of the elliptic. This chain was next to the inside circle of the so-called railway, having each of the mould frames attached at proper intervals so as to carry them forward and round the ends of the elliptic. When the moulds were passing along one of the sides of the machine the pulp, in a properly prepared state, flowed from a receiver upon each in succession. As each mould moved forward with its load, it received a side shake, and was rapidly swept round the end of the elliptic. On its journey along the other side, the frame was turned completely over, the pulp coming into contact with an endless web of felt moving at the same speed, and in the same direction. The pulp and felt were heavily pressed together to remove as much of the moisture as possible, and the paper, as we may now call it, was taken from off the mould and retained upon the woollen cloth or web. This process is familiarly known in the trade by the term 'couching.' The moulds in their journey round the end of the elliptic were restored to their former position ready to receive a supply of pulp. The web of felt upon which the sheets were deposited carried them forward to a pair of press rolls at a point beyond the machine, where they were picked off by hand and piled above each other—this latter part of the operation being in hand-made paper mills termed the 'laying.'"

This machine no doubt did very good work, and several of them were made and sent over to France and Dublin, where they gave very satisfactory results, as compared with the hand-made process then in operation. They had, however, many manifest defects, which were never overcome, and which ultimately led to the construction of an entirely different machine; but it was found to be no improvement, and ere long gave place to the Fourdrinier machine, which was now being brought extensively into use.

Before entering upon a description of the process of manufacturing paper, as at present conducted in this country, let us look for a moment into what may be called a paper-mill of the past, although it is still busy at work.

In a secluded little hollow on the banks of a rather picturesque stream in the Midlands of

Scotland, stands the quaint little mill to which we refer. Though chemicals had not been unknown in this primitive little place, at the time of our visit none whatever were in use. The flax was being boiled by direct fire heat in an open cauldron, none of the steam-boilers now so generally in use having been introduced here. After being boiled, the flax was transferred from the cauldron to the breaking or beating engine, of which there were two of the most primitive construction. The whole operation was conducted in one engine, the process of disintegration not being carried very far. From the engine the stuff was run into vats, where it was diluted with water, and kept in suspension by an oar occasionally stirred. The house in which the vats and presses stand is somewhat interesting. Two vats occupy one end of the chamber, a hand-screw press stands in the centre, and another, not in use, at the opposite end. One man is at work making paper on the usual moulds. These he passes in turn to the coucher, who transfers the paper to a heap, on which a layer of felt has been last laid. The heap, or "post," after having attained a few inches in thickness, is passed to the press, which is worked by means of a long pole put through an eye in the screw, and shifted every quarter turn. Four men put the requisite pressure on the pole, and two boys attend to the replacing of the heaps in the press.

The paper, after having been pressed, is hung up to dry in lofts, where the winds of heavens have free play, and by-and-bye effect the desired end. It is then pressed again in the finishing house, where the torn or faulty sheets are removed, and the perfect ones made up into reams for the consumer. The production was about two cwts. per day. These operations go on from week to week, and, altogether, a more antiquated process it would be difficult to conceive.

In contrast to this, and in order that we may see something of modern machinery, we shall now, with the courteously-granted permission of the Messrs. Cowan, visit the Valley-field Mills. They are situated on the banks of the Midlothian North Esk, a stream which will be long memorable because of the prolonged litigation between the riparian proprietors and the papermakers, in reference to the pollution resulting from the nine paper-mills which stud its banks from Lasswade to Penicuik.

The Messrs. Cowan have on this stream no fewer than four mills. For our present purpose, we will treat them as one. Indeed, three of them are so close together that, although they have locally different names, they are widely known as the Valley-field Mills. Originally erected by the Queen's printer, in 1709, they passed into the hands of the Cowan family about 1780, and since then, by the skill and enterprise of the leading members of the firm, the works have developed to a marvellous extent—from a production of a few cwts. per week to about 100 tons. The Messrs. Cowan have had a share in the invention and introduction of improvements in the processes and appliances involved in the production of paper. To some of these we may have occasion to allude in subsequent lectures, our purpose in this introductory lecture being more general, and intended to open up the field for closer after-study. Six Fourdrinier machines are now fully occupied, and the gross annual production, chiefly of the finer sorts such as writings, drawings, plate, &c., is not much less than 5,000 tons. Sixteen large boilers keep twenty steam-engines, with an aggregate of 1,012 horse-power at work, and supply the steam for boiling the rags and heating the drying cylinders. Besides this, four water-wheels are leagued with the engines in keeping the numberless wheels and drums in motion.

The rag and esparto stores are chiefly on the seaboard, and as they are interesting only because of their great extent, we shall not linger over them, but at once proceed to the cutting and sorting-room. It will be convenient to confine our observations, as much as possible, to one class of raw material in describing the various operations, therefore we shall make our paper of rags, referring in passing to the modifications required in the treatment of esparto and other fibre-yielding materials of a similar nature. The room which we first visit is provided with long ranges of tables, along which, at convenient intervals, females busy at work are stationed. They are each provided with a scythe-like knife fixed to the table in a slanting direction, so that the face looks upward, and from the worker, whose duty it is to rip up the seams, cut off buttons, hooks, buckles, pieces of rubber, &c., and cut the rags into pieces, three or four inches square. The rags, after undergoing this operation, are placed according to their quality or colour into various receptacles provided for them. Previous to reaching the paper-mill the rags have been sorted or classified, but never to the extent required by the careful paper-maker.

The cut and sorted rags are next taken to the willowing and dusting machines which occupy an adjoining apartment. In the "willow" the rags are dashed about and the dust knocked out of them by a series of arms or spikes, which revolve with great rapidity inside the casing. From the "willow" the rags pass to the "duster," which is simply a perforated revolving cylinder set at an angle, in which they are tossed about, the dust passing through the perforations, and the rags discharging at the lower end, which is open.

In the case of esparto, roots and other impurities are carefully picked out. This operation is also performed by females, the grass being shaken out and passed over perforated tables in front of them. Whatever be the nature of the raw materials, they are now ready for the boiling house, which is a capacious chamber, with ranges of large boilers of the prevailing type on either side. Here there are also two very large diagonal revolving boilers. The charge for each boiler ranges from ten to forty cwts., and in addition to the fibrous materials, caustic soda, at the rate of so many lbs. per cwt., depending upon the nature and quality of the materials to be treated, is introduced with a due proportion of water. Having been duly charged, the boilers are closed steam tight, and steam turned on. From six to twelve hours are required to complete the operation of boiling. When the operation is completed, the spent soda liquor is drained from the boilers and evaporated, and the soda recovered and causticised in an adjoining building, the product being used again with a fresh quantity of rags or grass. The recovery process is not always one of choice on the part of the paper-maker, but often of necessity for

the purpose of obviating the pollution of streams. After what are called the "boilings" are run off, the boilers are filled with cold water, for the double purpose of cooling the material and removing a portion of the residual spent soda liquor. This second water when run off is called "coolings."

The rags are now removed from the boilers and again picked, the dusting and boiling processes having brought to light objectionable matters which had formerly escaped detection.

The breaking, poaching, and beating processes which follow this second picking, are all conducted in machines or engines of the same general construction. For our present purpose the description we have already given of the "Hollander" or "beater" will suffice. The engines are placed at different levels, the breakers being highest, so that their contents may be run into the poachers at a lower level. There are frequently two sets of beaters, the first and highest set being called "intermediates," and these discharge into the lower set, where the process of comminution is completed. In the breaking-engines the process of washing is conducted, and the tearing out of the fibre begun. The product of the washing or beating-engine is called "half-stuff." This so called half-stuff is bleached, or at all events mixed with the bleaching liquor, and partially bleached in the poacher. When the bleaching is not completed in the poacher, the half-stuff with the bleaching liquor is run down into stone chests, where the process is allowed quietly to proceed until the desired colour is obtained. The bleached half-stuff is drained and pressed, to remove the residual liquid, and is then put into the intermediate beater, where the remaining traces of chlorine are removed by washing, or destroyed by chemical agents, and the process of comminution carried to a considerable degree of fineness. The china clay, pearl hardening, or other loading materials, are generally put into the intermediate when this engine is used. In the beating-engine proper, into which the stuff is finally run, the process of disintegration is completed, and the colouring matter and alum size added.

The operations which we have thus briefly described are conducted in four separate apartments. The engine-house is a lofty, well-lighted, spacious room. The bleaching-house is lit from the roof, a large proportion of which is of glass, the natural bleaching action of sunlight being thus so far taken advantage of. The press-house contains a set of powerful hydraulic presses, capable of doing a very large amount of work. The bleaching liquor is prepared in a series of stone vessels fitted with agitators driven by gearing, and the liquor which drains from the residual lime is stored in large stone or slate cisterns.

Before the pulp or finished "stuff" is run from the beaters to the vats which supply the making machine, it should be in a very fine state of division and of perfectly uniform consistency. When diffused through a large quantity of water it should scarcely be distinguishable as fibre, but should have more of the appearance of a solution something like churned milk.

Having prepared our stuff we must follow it to the machine-house, where we shall see it with wonderful rapidity and nicety converted, by the Fourdrinier machine, into a web of perfect paper. The Messrs. Cowans' six machines are of various widths, and are placed in several houses. The reason of this is obvious in mills, where for many years the growth has been gradual, it is difficult to secure such a general arrangement of parts as one could desire, and which is indeed only attainable in erecting an entirely new establishment. It was in this mill that the Fourdrinier machine was first erected in Scotland. In order that we may have the opportunity of witnessing, under the most favourable circumstances, the conversion of pulp into paper, a very interesting operation, we shall choose one of the machines recently constructed by Messrs. George and William Bertram—a machine which makes paper up to a width of seventy-five inches, and is constantly employed on the finest classes of writings.

When the pulp is discharged from the "beaters," it is received into large vats, or chests, fitted with mechanical agitators to keep the pulp from subsiding and the mixture uniform. From the chests it is measured out, in steady, uniform quantities, into a mixing-box, where it is extensively diluted with water, or with the drainage from the machine wire, and then allowed to flow through the "sand trap." This may be described as a long, shallow tray, folded upon itself to economise space. The sand, and other gritty matters, which the previous processes have failed to remove, are retained in this "trap," or tray, hence it takes this name. From the "trap" the pulp flows into the strainers. These are of two kinds, but, for our present purpose, they may be described as a series of sieves, consisting of brass plates, perforated with very fine slits, through which the properly comminuted fibres pass, but which retain all knots and impurities of a similar character. This is the great purpose of the strainer, and it plays an important part in the production of a high-class paper. Without the strainer all sorts of specks and blotches would disfigure the finished sheet, for even the smallest speck of impurity is magnified into an offensive spot when it passes between the calendering rolls. From the strainer the pulp flows over an apron on to an endless sheet of wire cloth, which is continually carrying it forward. This endless sheet or band is carefully stretched upon, and borne up by a series of rollers, so as to form a perfectly flat surface on the upper side. The water, of course, passes through the meshes of the web, leaving the pulp more and more like paper at every inch of its journey. The wire has a slight lateral motion or shake communicated to it, which causes the fibres to sort themselves, and interlace in such a way that a closely compacted and strong sheet of paper is the result. Without the shake the paper would not be so homogeneous, and would tear more readily in one direction than another. The draining or drying of the pulp on the wire is promoted by very ingeniously applied suction-boxes, which are of equal width with the web, and are kept in a state of partial vacuum by the action of air pumps. The changing condition of the fabric, now taking shape, is rendered very manifest as it passes over those particular points, the pulp, visibly wet at first, is soon only moist, and before it reaches the end of its journey on the wire, the result is so striking that no one would hesitate to call it paper. There are many wonderful and ingenious processes

in the manufacture of paper, but none of them are so striking, interesting, and rapid of accomplishment as that by which the pulp, milk-like at the beginning of the wire, is in six seconds of time converted into beautiful, though moist, paper. I have frequently had the pleasure of showing and describing to intelligent friends the manufacture of paper, and I have always noticed that this part of the process was the most attractive and interesting.

The width of the paper is regulated by what are called "deckle" straps or bands, which move with the wire, and can be adjusted to any width which the machine is capable of making.

It is while the paper is still on the wire, and generally immediately after passing the first suction-box, that the impression is given to it, by what is called the "dandy roll," which creates the distinction of "wove" and "laid" as applied specially to writing papers. From the same roll, names, and trade-marks, which are known as water-marks, are impressed upon the fabric. There is virtually a thinning of the paper where the marks on the "dandy roll" touch the sheet, so that what is thus imprinted can never be effaced from the paper.

The moist paper as it reaches the end of its journey on the wire passes underneath, and is pressed by what is called the "couch roll." Immediately on passing this, the paper leaves the wire and is received on an endless web of felt, by which it is carried through the first press rolls where a quantity of water is removed, and the fibres more closely compacted. By an ingenious arrangement the felt and paper are carried forward to the next press rolls in such a way that the surface of the paper previously in contact with the felt is now in contact with the metal roller, and *vice versa*. This arrangement was devised with the view of equalising the surface as much as possible, and although a decided improvement is effected by it, the impression made by the felt in passing the first press rolls, is never completely effaced. The press rolls are kept clean by means of scrapers or "doctors."

The paper, now sufficiently dry and compact to carry its own weight, leaves the felt and passes over to the drying cylinders, which are made of cast iron, turned smooth, and heated by steam. The paper is carried round each cylinder in succession, and is kept in close contact with them by means of endless felts, working over a series of rollers placed round each cylinder. Having been thoroughly dried in this way, the paper, in ordinary cases, would have, with or without passing through a set of calendering rolls, been wound into reels and removed from the machine, to be cut up and finished elsewhere; but, in the case of the machine before us, the paper has not yet made half its journey. As the paper leaves the drying cylinders it is warm, and, therefore, not in a good condition to be surface-sized; it is consequently passed over a roller, kept cool by a current of cold water circulating through it. Having been cooled, the web is immersed in the size, or gelatine, which is contained in a trough, or tub, in which a roller works, and by its means the paper is taken down into, and carried through, the size. It is thus thoroughly impregnated with gelatine, the surplus of which is removed by another pair of rollers, between which the web, again wet, passes.

A new and entirely different drying process now begins. Steam drying would destroy the size, and render the paper brittle; a much slower process is therefore adopted, in which air currents act as the drying agent. The drying apparatus before us consists of no fewer than 200 skeleton cylinders ranged in three tiers; inside each cylinder, but revolving independently of it, is a fan for producing currents of air. The fans, which move slowly in the earlier cylinders, increase in speed as the paper moving forward gets drier, and better able to bear the action of stronger currents. The web is guided along through this labyrinth of cylinders by means of tapes or bands, and by the time it reaches the end of its journey is perfectly dry, and able to bear and benefit by the pressure of the calendering rolls through which it passes previous to being cut up into sheets. This cutting up is the final operation to which it is subjected in this wonderful chain of processes. In the short space of seventy minutes, and without a break in the continuity of the process, the paper is made, sized, dried, calendered, and cut into sheets. Pulp at the one end of the machine, sheets of fine writing-paper at the other. It may be mentioned that the length of paper on the machine at one time is about a mile.

The machine we have described is one of the very few in this country on which the various processes are so continuous. The rest of the machines in this mill finish their work as most others do by winding the paper engine-sized or unsized, as soon as dried, into reels. These reels in the case of printing papers are at once transferred to the cutting machines, where they are first ripped up into widths and immediately thereafter cut into lengths. In the case of engine-sized writings the reeled paper is simply ripped up into two or three widths and reeled again, then passed through the web calendering machine, and finally cut into sheets. Paper intended for surface-sized writings or such like is transferred to the sizing tub, and air dried in the same manner as we have already described in the case of the continuous machine, then cut into sheets and taken to the finishing house, which is an extensive establishment, lofty and well lighted. Here we find many nimble fingers at work making up the sheets into piles about an inch thick, each sheet being separated from that above and below by plates of copper of corresponding size. These piles are passed backwards and forwards several times between the rollers of what are known as board calenders, which gives the paper a fine smooth surface. If a very high glaze is required, the sheets of paper and copper are interchanged and again passed through the rollers, and this may be repeated several times. Of course each sheet is carefully examined, and all marked or faulty ones removed and piled into a heap by themselves.

There are many other interesting, although secondary, processes in operation in such extensive establishments as the one we are now describing, but these we can only briefly refer to at present. There is, for example, the house for preparing the bleaching liquor, in which are placed a range of large stone cisterns fitted with mechanical agitators; the size house, where the "scrows," or raw material of animal size, are steeped and cleaned, and finally dissolved in copper vessels fitted with steam jackets; the apartment where

the china clay and starch are prepared for the beating engines; the sheet-sizing room, and air drying lofts, where the old method of treating hand-made papers is applied to machine made writings in a modernised fashion. There is also the stamping house, where the finished paper is bundled up and weighed, and the extensive stores for the various classes of finished goods. Then we have the usual ranges of mechanics' shops; the engineering establishment, with its planing, turning, and boring machinery; the carpenters' shops, with all sorts of appliances constantly under construction; the smithy, with its blazing fires and sounding anvils; the plumbers' quarters, where lead is made to assume many a fantastic shape, to suit the exigencies and intricacies which it is intended to meet.

Besides all these we have the extensive water system; water for driving purposes, collected and deviated by a weir thrown across the Esk, and led into the mill by a race or lade to the various water wheels and turbines; water for washing and for diluting the pulp for the machines, collected from various pellucid springs, and stored in extensive reservoirs. The purity and abundance of the water supply of a paper mill is of the utmost consequence, and in many cases the character of the available water determines the character of the paper to be made. The water, after having served its purpose in the mill, has to be got rid of in some way, and as it has acquired much impurity in the various processes, it is not allowed to flow direct into the stream, but must first be purified as far as practicable. We have, consequently, a large area occupied with settling and precipitating ponds, filters, drainers, and evaporators.

Lastly, we have the iron way, with its locomotives, "Valley-field" and "Inveresk," carrying the raw materials into every corner of the mill, and removing the beautiful finished product to be distributed all over the world, to what diverse purposes to be applied I leave each one to picture for himself. The history of the application of the product of one day's work of such a mill would certainly afford pictures of both the gravest and the gayest types, and would be more deeply interesting than the finest strung romance; the various themes upon which ten thousand heads and hearts would discourse on the sheets; the many errands on which they would be sent, and the many emotions which they would kindle in every clime we can only faintly imagine.

I conclude this lecture with some statistics of the trade, which will serve to give an idea of its magnitude and of the universal application of the product.

The number of mills at present working in England is about 300, in Scotland 65, and in Ireland 20, in all about 385, being an increase of 40 or thereby in the last decade. The total number of machines at work in the three countries is about 526, producing an annual aggregate of 350,000 tons, to which must be added say 10,000 tons made by hand, making our total production 360,000 tons, the value of which may be taken at £16,000,000 sterling. Our exports are about 16,000 tons, but we import 24,000 tons, showing that we consume 6,000 tons more than we produce.

Of the raw fibrous materials used in the production of paper we import between 17,000 and 18,000 tons of rags, and 190,000 to 200,000 tons of esparto and other vegetable fibres. The gross value of these imports is about £1,700,000.

Dr. Rudal, of Vienna, gives some interesting statistics, and although they appear to be rather out of date, in the absence of more recent accurate information we may note a few of his figures. He gives the total amount of paper made on the globe at 1,800 million German pounds per annum, one-half of which is used for printing, one-sixth for writing, and one-third for other purposes. The aggregate number of persons, male and female, employed in the manufacture, he gives at 270,000, with an additional 100,000 employed in gathering rags.

Dr. Rudal also informs us that a Russian consumes annually 1 lb. of paper, a Spaniard $1\frac{1}{2}$ lbs., Mexican of Central America 2 lbs., Italian and Austrian 5 lbs., Frenchman 7 lbs., German 8 lbs., United States $10\frac{1}{4}$ lbs., and Englishman $11\frac{1}{2}$ lbs.

MISCELLANEOUS.

HEALTH.*

By Edwin Chadwick, C.B.

(*Continued from page 55.*)

Progress of Sanitation in the Army.

I now beg leave to submit to your attention the progress of the principles of sanitation under public treatment and collective observation—namely, of our military forces at home and abroad. On the outbreak of the Crimean War I went myself, as the chief executive officer of the first general Board of Health, to the War-office, and ventured to express my doubts as to the sufficiency, not of the medical or curative, but of the preventive service. I was met by assurances of perfect confidence in the completeness of all preparations. In the result, however, a victorious army fell, not by the sword of the enemy, but by insanitary administration. The first outcry was to charge the disaster upon the insufficiency of the rations to sustain force. A Commission was sent out, and the rations were amended. But good food does not suffice against bad air; the food was improved, but sickness of the troops continued. Independent remonstrances were made by Lord Shaftesbury and others, and by myself in a pamphlet I wrote on the subject for Lord Palmerston.† A Royal Commission, formed of the chief staff of trained officers of our Board, was sent out, and as a result of the sanitary measures proper, as was declared by the then War

* Opening Address to the Health Section of the Social Science Congress.

† See "Life of Lord Palmerston," vol. ii. p. 81-82. On February 22, 1855, the late Lord Palmerston wrote:—"My dear Lord Raglan,—This will be given you by Dr. Sutherland, Dr. Gavin, and Mr. R. Rawlinson, whom we send out to put the hospitals, the port, and the camp into a less unhealthy condition than has hitherto existed; and I request that you will give them every assistance and support in your power. They will, of course, be opposed and thwarted by the medical officers, by the men who have charge of the port arrangements, and by those who have the cleaning of the camp. Their mission will be ridiculed, and their recommendations and directions set aside, unless enforced by the peremptory exercise of your authority. But that authority I must request you to exert in the most peremptory manner for the immediate and exact carrying into execution whatever changes of arrangement they may recommend; for these are matters on which depend the health and lives of many hundreds of men—I may indeed say of thousands." The Commissioners landed in Constantinople on March 6th, and immediately commenced cleansing operations in the large hospitals at Scutari, with results fully set forth in their Report.

Minister, Lord Panmure, the second army was saved, and returned in a better condition of health than the army at home. It marks the antipathy, or at least the apathy, with which sanitation has to contend—of which other large examples may be adduced—that whilst every official through whose misfeasance the first army was lost was decorated, not one of those through whose sanitary science the second army was declared to have been saved received then or since the slightest notice for the achievement. Chiefly at the instance of Lord Herbert, under the influence of structural improvements advised by the Army Sanitary Commission, army sanitation has advanced, under more or less perfect provisions, from a death-rate of 17·5 in the year 1858 to a death-rate of 9·06 for the whole army in 1875. The death-rate of the Foot Guards was, in 1858, 20·4 per 1,000.* It was last year 7·72. The deaths amongst them from continued fevers have been reduced from 2·45 to 0·44, and by tubercular diseases from 12·53 to 1·69 per 1,000 of mean strength. New hospital accommodation, provided on the old experience of the curative service of a constant bed-lying sickness of 100 per 1,000 of force, has been found to be in excess to more than the double of what is now required. The effects of sanitation in the army have been progressively manifested in the army on foreign stations, in some instances to a considerable degree, of which I will mention one—the instance of Gibraltar, where, from 1818 to 1836, there was a death-rate of 21·4 per 1,000. Progressive reductions have followed barrack improvements, general drainage, water supply, and other sanitary works there, until 1875, when the death-rate was 5·50 per 1,000, and the place is made the most healthy spot out of England for troops. I may here state that, at our meeting at Liverpool, in 1858, I read a paper demonstrative of the importance of the application of sanitary science to the protection of the Indian army. The representations then made met with concurrent support, and were followed by the appointment of a competent and efficient Royal Commission of inquiry into the state of the Indian army, in 1859. The Report of this Commission stated that the death-rate of the British soldier since the first occupation of the country has oscillated round 69 per 1,000. Dr. Cunningham gives the present death-rates among the British troops in India at 17·48. The average rate of the preceding four years has been 17·65, though 1875 was a great choleraic epidemic year. These are the death-rates in India, but as some die on the voyage home and others at Netley, the total death-rate has been 18·52. On a threatened invasion of our West Indian possessions by cholera, we were called upon at the General Board of Health to organise a Sanitary Commission for defence. One result of that examination, chiefly conducted by Dr. Gavin Milroy, was to show that the excessive ordinary death-rates there (50 in 1,000) and the assumed impossibility for the white races to live and have succession there, were mainly the results of insanitary conditions. The army sanitary statistics are confirmatory of that view. In the Leeward command the death-rate was from 1819 to 1836 no less than 96 per 1,000. Great improvements have been made at all the stations of late years, and the management of white troops has been much improved. In 1875 the death-rate was 5·98 per 1,000. As in the prisons so in the barracks, it may now almost be said that epidemics are not permitted there. Whensoever any occur there an inquiry is made as to the causes with a view to their removal, whilst epidemics carry away thousands of the civil population, the industrial forces of the country, without any proper inquiry whatsoever.

Shortcomings in Army Sanitation.

The foregoing results may be accepted as great and telling demonstrations of the power of sanitation, but in the service of this science, we should reckon nothing done whilst aught remains to do. For sound fault-finding is promotive of further progress, and with our knowledge of the subject, we should change our aspect of felicitation to an aspect of severe discontent with the shortcomings of the administration. It may be demanded why the death-rate of the Foot Guards should be 7·72! why should it be above that much exposed service, the police, which has now a death-rate of only 5 in 1,000, instead of 11 as formerly? Why should the death-rate of the Foot Guards be above Gibraltar, which was 5·50. There are yet fevers in the baaracks combined with other diseases, which ought not to be there any more than in the prison—there are some 50 per 1,000 constantly sick amongst the selected strong lives of the barrack, and not above 10 per cent. amongst the unselected and low and bad lives of the prison, even with the diseases brought with them. Then we have yet a death-rate of 9·36 for the whole of the home army! such a contrast to Gibraltar—strong selected lives, a death-rate, even threefold greater than the wretched population of the prisons! This, surely, ought not to be, and with due support to the sanitary administration, which has done so much, it would not be.

A Norma of General Sanitation in a Tropical Climate.

In respect to tho sanitation of the Indian army, I may present one norma for use. Some time ago I was informed of an example of the power of sanitation on a tract of land in Algeria, which it was necessary to occupy, and, if possible, to colonise for strategetical purposes; where, however, three sets of colonists had been swept away, and three sets of military forces dislodged by a death-rate higher than the worst that ever prevailed amongst our army in India. Subsequently the place was skilfully drained, supplied with water, and appropriately cultivated, with the result that the malaria and the malarial fevers were nearly abolished, and the birth-rate made as good as in a rural district in France, and, indeed, to exceed the death-rate of the colonists; and the death-rate of the soldiers was reduced to about 13 in 1,000. At my instance, our then Minister of War, Lord Ripon, directed the place to be visited and the work to be examined by a special Commission, on which were Dr. John Sutherland, Lieut.-Col. Ewart, R.E., Dr. Paynter, and Mr. Robert Ellis, C.B., of the Sanitary Commission of Madras. But that I was prevented by illness, I deemed the example so important, that I should have accompanied them. By them the results were verified, and pronounced to be generally applicable to India. It showed that for the protection of soldiers, sanitation must extend beyond the four walls of the barracks to the cantonments and to the habitations of the connected populations.

To go with an army under insanitary commands is to incur threefold greater danger of death from disease than from the sword. To go with a working army, for settlement under sound sanitary commands, is for the settler to go with threefold greater security for himself and family against disease—tropical disease—than if he went alone.

* It is due to state that Lord Fortescue, in 1856, gave notice of four resolutions on army sanitary reforms, of which the first was, "That the continued excessive mortality of the British army has been mainly caused by the bad sanitary condition of the barrack accommodation," and the last was, "That, in the opinion of the House, such increase and improvement of the barrack accommodation are imperatively called for, not less by good policy and true economy than by justice and humanity." In collecting materials for his speech, he visited many barracks and military hospitals; and, only a week before the motion was to come on, Lord Fortescue caught the ophthalmia in one of the hospitals, by which he lost the use of one eye. Whilst on a sick bed, he was gratified to hear that a Royal Commission had been issued to inquire into the subject, which presented a very able report, drawn up by its chairman, Mr. Sidney Herbert, before Lord Fortescue was able to make the motion which had been standing *in extenso* on the notice paper before he was taken ill in 1856. That report led to great improvements being at once made by Lord Derby's Government in 1858, which was followed up by subsequent Governments, and on May 11, 1858. Lord Fortescue moved, and carried, without a division, the four resolutions which he had given notice of in 1856.

Not solely by the one recited norma of sanitation, but on other evidence too long to recite, I believe that the death-rate of the Indian army and its sickness-rate are yet at least full one-third higher than it ought to be, or will be hereafter under a good administration. The present loss from defective army sanitation amounts to between four to five hundred deaths annually, and the preventable sickness of some 1,600 or more of our small and valuable force. Added to these are the enormous losses of civil population from the dereliction of governmental duty in respect to them, and the inaction arising from administrative ignorance and apathy, which has its pretext for inaction in the assumed difficulty of overcoming the habits of the population, and the ignoble assumption that ignorance is impregnable.

Economies from past Army Sanitation.

All the shortcomings may be treated as waste, of military as well as of civil force, which have to be measured by the gains derived from past sanitation. Let me state some of the gains of military force so obtained as indications of future practical economy from sound sanitary administration.

The death-rate of the home army was 17 per 1,000 up to 1857. This, on a man-strength of 88,147 men, gives 1,840 deaths. But the actual deaths were only 870, showing a saving of 670 men—a battalion nearly. At £100 per man this represents a saving of £97,000 per annum in the home army. As to the Indian army, the latest return shows that it amounts in round numbers to 60,000 men. A death-rate of 69 per 1,000 implies 4,140 deaths per annum ; but at the present rate, all told, at 18 per 1,000 per annum, there would be required only 1,080, or 3,660 fewer deaths than under the old death-rate, and on the calculation of the Royal Commission this gives an annual saving of £366,000 per annum, which ought to be half a million under effective sanitary administration. The army was smaller, but under the old insanitary and merely curative rule, there would have been 10 per cent. of sick, that is to say, 6,000 men out of an army of 60,000 always in hospital. At present the numbers are 3,360, too many by one-half, the result of still defective administration, but it shows nevertheless three battalions of men more in the effective of the army than would have been the case formerly with an army of the present strength.

Progress of Sanitation in the Royal Navy.

I now advert to the progress of sanitation in the Royal Navy. Dr. Johnson, now just a century ago, thus spoke of it : "As to the sailor, when you look down from the quarter-deck to the space below, you see the utmost extremity of human misery ; such crowding, such filth, such stench. A ship is a prison with the chance of being drowned ; it is worse, worse in every respect ; worse air, worse food, worse company." This, which was said of the Royal Navy then, may be said of the mercantile marine now. Such events as occurred in Anson's time may be stated to be impossible in the Royal Navy, in which now the death-rate from disease alone in the total force was, according to the last report, 6·9 per 1,000. This is little more than one-half the death-rate prevalent amongst the men of the same ages of the civil population. Nevertheless, it appears to me that the progress sf sanitation in the navy is yet unsatisfactory. It was 6 per 1,000 as early as 1830. In 1835 it had been get down to 4·9. Some observation in experien ce of the preventive vigilance exercised in transport of pauper emigrants when payments were made only on the numbers landed alive, and a consideration of the species of disease yet too prevalent in the Royal Navy, under former conditions denoted by Dr. Johnson's expression, the mortality on board transport ships was terrific. The Indian Government have now, however, sanitary troop-ships, for the outward voyage in which the death-rate from disease is under 3·1 per 1,000. Indeed, the transport returns for 1876-7 show a death-rate of 2·6 per 1,000—that is to say, about the same death-rate as in the best ordered prison on shore, and less than half the death-rate in barracks ;—less than a third of the dath-rates of the wage classes under corporate rule, and this with no greater than 50 cubic feet of space. Of course enforced temperance in the floating prison, as in the stationary prison on shore, has much to do with this ; but there are no epidemic outbreaks in these ships. On the return voyage many of the men who are sent home, as invalids or on sick leave, land quite recovered. Making all allowances for differences of exposure to external contagion ;—the death-rate and the sickness-rate prevalent amongst the selected population of the moveable prisons afloat ought, I consider, to be brought much nearer to the normal sickness and death-rates of the unselected, primarily diseased, and altogether inferior populations of the fixed prisons on shore.

State of Sanitation in the Mercantile Marine and as Affecting Quarantines.

But what is the state of sanitation for the conservancy of force, for the maintenance of our great mercantile marine, in its competition with the mercantile navies of the world, of the total tonnage of which, according to the last returns, whilst only 2·57 was Dutch, 5·51 French, 6·30 German, 15·03 American, not less than 37·51 was British, worked by 200,000 seamen, of whom about 10 per cent. were foreigners? What since 1849, when at the general Board of Health, examining for the settlement of the question of quarantines, we found our mercantile marine subject to frequent outbursts of epidemic diseases on long voyages, amongst animals as well as human beings, long after reputed periods of incubation, and under conditions sufficient apparently for spontaneous generation of the diseases assumed to have been conveyed from distant land sources—what, in these states of things, have been the advances made, and the sanitary normas obtained—if any—in this great field for sanitation? The only answer that statistics give is the continuance of a nearly threefold death-rate beyond that in the Royal Navy has been reduced, and the continued prevalence of diseases banished thence in the mercantile Marine. Our report was translated into French and Italian, and our evidence was examined and discussed, and its sanitary application to ships was finally adopted, by a congress of the consular and sanitary officers of twelve of the States of Europe in 1851, when Dr. J. Sutherland appeared as representing our principles. Since then a reactionary movement took place, in support of the hypothesis of the exclusive propagation of disease from person to person by human intercourse, and for prevention, not by sanitation, by the cleansing of places or persons on shipboard or on shore, but mainly by checking that intercourse, by quarantines, by burning clothes, by disinfecting goods, and by destroying germs, the assumed agents of contagion. Subsequently, however, it has been seen that human intercourse on shipboard has been speeded by steam, and on shore by railway transit of people in masses, comprising people with undeveloped disease, of the nature of which they are themselves unaware, unrestrained and unrestrainable by any quarantines ; yet the spread of pestilences has not been proportionately speeded and spread as it should have been, according to the contagionist theory. On shipboard in large transports, we have seen that the passengers have been conveyed with as much safety from epidemic attacks almost as if they had been in a well-managed prison. On shore, I remember the time, when in a town in the most insanitary condition, even a medical officer has ascribed an outburst of an epidemic to its introduction by a tramp from a common lodging-house where it first appeared. Here in Scotland people and police, on the alarm of a coming visitation, have given their whole attention to keeping out tramps. Now, as I may show, well-regulated common lodging-houses have almost an immunity from epidemic attacks, and the

tramp's superior security will be in not going to an ill-regulated place, or into any dwelling in a low neighbourhood occupied by the wage classes. In India it has always been held that pestilence has been carried about and introduced by pilgrimages, verified, as is natural, by the disease being rife amongst the moving masses, and the remedy was, if possible, to arrest them; but Mr. Robert Ellis, C.B., a sanitary commissioner of Madras, who unfortunately for our cause, has been suddenly removed from amongst us, attacked with sanitary regulations one of them which had been the source of frightful epidemics, and ensured protection and freedom to the moving masses. Even in France no better views have obtained until lately. It was a belief that the King Louis Philippe conveyed typhus about; for was it not seen that, year after year, so sure as he went to Versailles, there was an outbreak of typhus, as there certainly was under the common military insanitary commands, until a medical officer, conversant with sanitation, pointed out that the evil was due to the overcrowding of the barracks by a double population, composed of the King's band and *entourage*, and other conditions, which being amended, the accustomed visitation of fever was prevented, and health was maintained. We know too well the losses incurred in the movement of military forces under insanitary commands in tropical climates. On the announcement of the visit of the Prince of Wales to India, serious apprehensions were entertained, which were well founded under the common conditions of such a progress, under which seasoned men have suffered, until it appeared that a good sanitary body guard and a sanitary escort were provided for his security, and that a sanitary force prepared the way for him; and, as the event proved, gave to him and his *entourage* security against dangers, which the strongest merely military or insanitary escort of infantry, cavalry, and artillery would in all probability have aggravated.* It is observed that by the application of sanitary principles, on the occasion of the Prince's visit to Calcutta, when there was an immense influx of foreign population into that city, such as to have engendered an epidemic outburst under insanitary conditions, the public health in no way suffered. Continued observation of the movement of cholera, in its great source and constant seat, have negatived distinctly the reactionary hypotheses, and maintained our conclusions. Amongst other points it is shown that cholera passes over wide tracts almost desert and with sparse population, quite away from all highways of intercourse. Closely quarantined districts there have suffered severely from the epidemics, whilst unquarantined districts have suffered little. The Commissioners state in their last report "that facts regarding the movement of cholera show that, whether or not cordons be drawn round stations, no dependence can be placed on them as a protection against cholera, while the employment of troops may be a direct means of augmenting the mortality." They say that "the entire chain of facts shows the necessity of coping with the disease in the localities themselves, for upon the continued progress of sanitary improvement, especially in the purity of drinking water and of the atmosphere, cleanliness, surface-drainage, &c., in the towns and villages of India, it depends whether the intensity of each succeeding epidemic shall be less or greater than that which has preceded it; so far, at least, as past experience enables us to judge." Of minor subsequent observations, confirmatory of the declaration that in none of the quarantine stations was there an instance of the propagation of the plague by goods, it was shown in the rivers pollution inquiry, that upwards of 70,000,000 pounds of woollen rags are annually imported largely from districts where plague, fever, small-pox, and loathsome diseases prevail, and that these uncleaned rags are there (in Yorkshire) sorted by human fingers, before being placed in machines which tear, and separate, and cleanse the fibre for manufacture into "shoddy," and that for fifty years the manipulation has not been found injurious to the health of those engaged in it. A similar inquiry made at Paris amongst the paper manufacturers, with a view to ascertain the propagation of small-pox by unclean cotton and flax rags, was attended by similar results.

These facts are stated simply as confirmatory of our conclusion that, be it as it might with any other means of transmitting disease, there was no justification for staying the transit of manufactured goods from any infected place, as one of them. Of the means proposed of prevention by disinfectants, as they are assumed to be, we have had strong evidence that they were only deoderants. Powdered charcoal was put forth as a powerful disinfectant. The crew of the ship loaded with it for the Crimea were severely attacked by cholera, when the blue stages of the disease were almost masked by the charcoal powder on their faces. One inventor of a preparation of acetate of lead who almost threatened us with condemnation for manslaughter if we did not exercise our authority to enforce its general use, died from the epidemic, poor man, amidst a magazine of his confidently declared infallible preventive. Admitting fully the infectiousness of certain febrile diseases, it would be unjustifiable to trust to any supposed disinfectant for protection. But nature has given us the means always at hand, without cost or difficulty, of perfect safety; complete personal cleanliness of clothing as well as persons, abundance of water, and replacing the foul infected air round the sick by dilution in the boundless external atmosphere. In the words of Miss Nightingale, cleanliness and fresh air are the only protection which a nurse requires. "True nursing," she says, "knows nothing of the infection except how to prevent it. Cleanliness and fresh air from open windows are the only defences a true nurse either asks or needs." What is true of a sick room or hospital is equally true of all sources of infection. Clean skins, clean clothes, clean ships, clean houses, and clean air are the only disinfectants because they prevent infection. Later observations have more clearly defined the limits of infection under conditions of cleanliness and ventilation.

The special Commission appointed in France to determine what course should be taken for protection against cholera, after reciting our statements with approbation, say:—"Ce sont les vues et les pratiques en Angleterre dans ces matières, vues bien fondées, pratiques, parfaitement rationelles que le general Board of Health s'efforce de faire prevaloir et que, il faut le croire, deviendront le base de toute système sanitaire."

The sum of the observation of facts has been a re-vindication of the general conclusion of our report as regards shipping, viz.:—"That the substitution of general sanitary regulations of ships in port for the existing quarantine regulations would far more effectually extinguish epidemic disease, and afford better protection to the uninfected on shipboard, whilst it would relieve passengers and crews from grievous inconvenience, abate the motives for concealment of sickness and false representations as to its nature, greatly lessen commercial expenses, and remove obstructions to the free transit of goods and uninfected persons, which the existing system of quarantine occasions. It follows that we propose the entire discontinuance of the existing

* By sanitary commands every arrangement was made for his passage through highly dangerous districts before a tent was pitched. "Camps fell into their places in perfect order, and surplus animals were removed to the open country. There was no over-crowding anywhere. Surface sweepings were at once buried in shallow pits. The trench system of latrines, with the immediate burial of the sewage under a covering of dry earth, was resorted to, and officers were told off to see that no nuisances were anywhere permitted. Wells for drinking water were marked by flags, and care was taken that no other water was drawn for the purpose. Two temporary hospitals were provided, and provisions made for immediately reporting all cases of sickness. The consequence was that not a single case of any epidemic disease occurred in camp:—that the daily sick lists contained reports of trivial cases of sickness or accident only, and were blank for many days."—"Indian Sanitary Reports for 1877," p. 210.

quarantine establishments in this country, and the substitution of sanitary regulations." At a late Congress it was found necessary to abate reactionary measures and return towards our doctrine.

The evils of unfounded hypotheses in the maintenance and propagating of disease—amongst others, in diverting attention from the proved means of security, by sanitation—have operated most injuriously in the maintenance of the comparatively low condition of our great mercantile marine. The elements of efficient sanitation—cleanliness, good dieting, good clothing, and care for their regular and orderly application—tend to comfort, and sobriety, and security, and altogether constitute in sanitation a factor opposed to drunkenness, disorder, and insecurity, and the waste of property as well as the waste of life and of force. The statistics for one year will serve to indicate the conditions of our mercantile marine in respect to the waste of life and force as well as the waste of property. Of the total number of persons in the mercantile marine (203,000) there died 2,700, being a death-rate from disease of about 13 per 1,000, as against 6 per 1,000 in the Royal Navy. An excessive proportion of the deaths in the mercantile marine were from the preventible foul-air diseases—fevers, cholera, dysentery, diarrhœa. The total deaths from all causes were 4,076, the rest of the deaths being about two-thirds from shipwreck, and about one-third from violence and accidents. The mean death-rate of seamen in the mercantile navy, on the returns of the last three years, appears to be about 20 per 1,000 from all causes, as against 8 per 1,000 from all causes in the Royal Navy; but these rates for seamen in the mercantile marine do not include the deaths of passengers, who, so far as may be distinguished in an average of eight years and a half would be one-third more, making up the total death-rate of the mercantile navy to threefold that of the Royal Navy. It may be mentioned, as indicating the state of disorder of the mercantile marine, that the total number of desertions within the year (1875) was 28,800, that 3,700 were imprisoned, that 23,900 were discharged, and that a total of 60,000 left before the period for which they had signed articles, and that 49,600 were engaged subsequently to the commencement, apparently to make up for the desertions.

The contemplation of such results, with knowledge of the insanitary conditions, or of the economical and other conditions involved in them, is very painful, and on my appointment, as a political economist, to preside at the Department of Economy and Trade, at our meeting at Sheffield in 1866, I could not help making the losses of life and property at sea the subject of my address, especially to call attention to the economical aspect of the great waste involved, and particularly to the lethal influence of full insurance in reducing responsibilities for ignorance in the commands, and the bad conditions of the crews. I believe that Mr. Plimsoll was of our audience. The facts were well-known to the officers of the Department, who were aggrieved at their failure to gain attention to them and action upon them from their changing political chiefs; and I was not more successful. But where quiet but strong and earnest remonstrance failed, passionate sympathy has succeeded in getting public and legislative attention to the tragical losses by shipwreck and to some of the grievances of the men. There has not been time yet to judge of the results of the measures obtained, and statistics show as yet no reduction of these casualties. Nevertheless, the hulls of vile craft are now to be seen rotting in ports, that, but for the measures already taken, would have been at sea, to the destruction of life by disease as well as by disaster, with fully insured cargoes, but for the recent measures. I hope and believe that a reduction of the losses on the coast have been materially reduced by them.

But the death-rates continue to show that the great insanitary evils remain in almost unmitigated force in our mercantile marine. I do not advance the normal death-rate of the royal marine as immediately and strictly applicable to the mercantile marine. The mercantile marine has, I believe, normas within itself which I had not the means of eliminating. Indeed, ships of those great and grand mercantile organisations, the Cunard Line, which has never lost a ship or a passenger; the Peninsular and Oriental Company; and the Royal Mail Companies' fleet, which become our maritime position, may well compete in sanitation as well as general security with the best of the Royal Navy. I believe that other less public mercantile organisations may rank with them. But the elimination of these important instances only make the common death-rates the heavier, and the preventible causes of evil the more gross. The continued evil of the mercantile marine, and the obstruction to its sanitation, is the ignorance of its commands. When we were charged with the sanitation for the prevention of cholera, measures for the provision of protection of persons on shipboard, we sent inspectors, and transmitted instructions, to our consuls at the chief foreign ports, to communicate them to ship captains for execution. We were then told in despair by the consuls, that we would be surprised if we had their experience of the ignorant ruffianism and recklessness of much of our mercantile commands. This corresponded with what I learned in our inquiry, under the Constabulary Force Commission, into the practice of wrecking on our coasts. The extensive continuance of such conditions—notwithstanding such measures as have been taken to ensure fitting qualifications for command—is displayed by the results of the most recent inquiries into the causes of wrecks, a large proportion of which are proved to have been occasioned by culpable recklessness or incapacity. A late statement by our consul at Pernambuco of his observations of the mercantile commands may be cited as corroborative of our earlier information on the topic. He states that "numbers of British shipmasters are no better than ignorant, pugnacious, and obdurate seamen," and that to their unfitness to be placed in charge of men and property the loss of many lives and a large quantity of property annually must be attributed; and he quotes an illustrative instance of disorder from the log-book of a vessel which left the Mersey with all the crew except two boys in a state of intoxication, "with a crew in a condition in which a cab driver would not be allowed to proceed along a street." A fact came to my knowledge which is pregnant with a large promise for the future for sanitation and for economical results, namely, in practical training on the half-time school principle. In some of those distinct half-time schools to which I have referred as primary normas of sanitation, the boys have much of their requisite physical training at the mast. Those at the Limehouse school were orphans and destitute children of the very scum of the port, which supplies material such as we see for the merchant navy. They were free to choose their course. Many had tempting offers of good wages on board merchant vessels, but the great majority of those who were bodily fit volunteered for the Royal Navy. I inquired why they did so. Was it the martial glare of the Royal Navy that affected the imaginations of these boys? No, their choice was deliberate. The general ground assigned for the rejection of the mercantile marine was, "that it was so dirty and so disorderly." This was from boys, the children of parents the scum of the streets.

The practical outcome from the mixed physical and mental training in a high order of sanitation on the half-time principle (some of which we have had the pleasure of seeing in Sheriff Watson's school and the training ship at Aberdeen), in begetting a repugnance to filth and disorder, and a preference, even at a pecuniary sacrifice, for cleanliness and order, is an outcome for national exertion to make generally prevalent amongst the whole population. I reserve it, to submit it, as a foremost topic for the special attention of the section of education.

I could not but inquire what sort of owners they were of these merchant ships who could appoint such com-

mands, so dangerous and so wasteful of the capital embarked in them. They were, so far as was known, chiefly small shopkeepers in the ports, people of the smallest means as capitalists, and of very narrow views. It would be well if this smaller service of single ships could be superseded by collectivity, in joint stock organisation, such as that of the great companies to which I have adverted, by which the existing evils must be abated. I shall not be understood as assuming that the smaller craft of the mercantile marine may be brought up to the sanitary condition of the Royal Navy. Nevertheless, some observations which I made on the transport of pauper emigrants under the authority of our first Poor-law Board, warrant a confident expectation that far greater sanitary as well as other beneficent results are obtainable than may be readily imagined, under the operation of the great master principle of administration, to which I have adverted, of making interest coincident with duty—by only paying for results. In the first voyages of transport ships the skippers were paid per head on the numbers embarked, and the explosions of epidemic and the losses of life on some of the long voyages were terrific. By a happy and simple change of the terms of the contract, they were paid only per head on the numbers landed alive, and to the terms on this principle we adhered. On going on board one of the first pauper emigrant ships under this form of contract, I was charmed by the way in which I was received by the skipper; he was so desirous, so pressingly anxious to receive any suggestion for the improvement of the sanitary condition of the ship. Of their own accord the skippers under this form of contract engaged ship surgeons for the care of the passengers, and transferred to these surgeons, medical officers of health, the pressing responsibilities of the contract, by making their enrolments dependent solely on the number of the passengers landed alive. The working of the principle was excellent. I was otherwise occupied, and obtained no statistical evidence, but my belief is, that the sanitary condition of the floating prison was brought very close to the norma I have adduced of the stationary prison, and I am very certain that there were no longer any epidemic visitations upon the passengers. The perceptions and observations of points of sanitation by the ship surgeons acting under these conditions, were acute, original, and highly instructive. Moreover, under these conditions, without benevolence and with the common everyday principle of interest, we did the work of uncommon, active, and enlightened benevolence. We at all events secured for every lone emigrant, who might after all be lost, at least one sincere mourner. If we could get the Legislature or local authorities to appreciate and apply the principle of the payment for results, and augment the salaries of officers in proportion to the reduction of death-rates, we should only have an advance in sanitation that to the public would be wonderful.

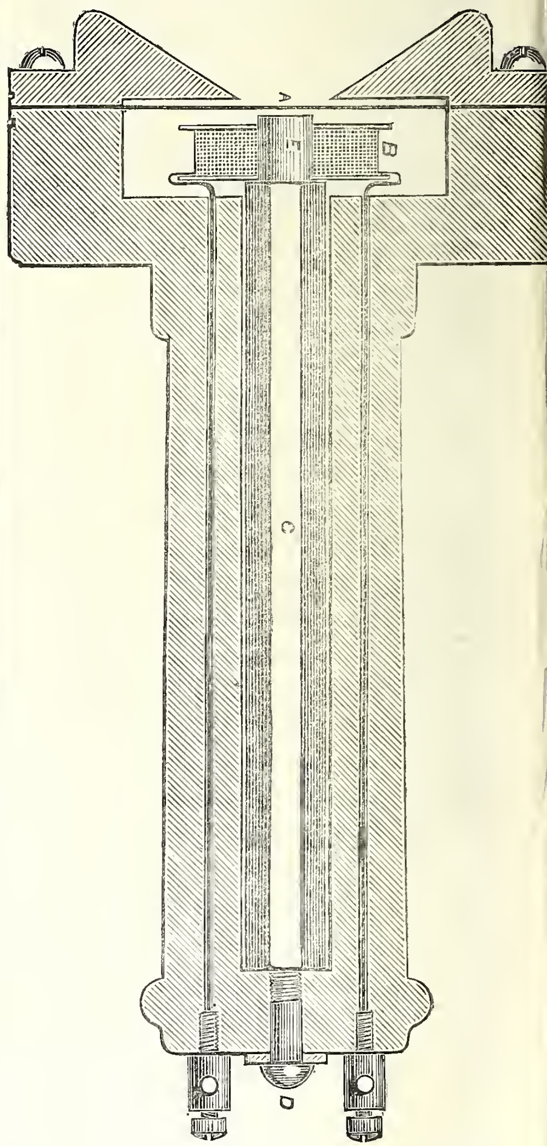
In tracing as I have endeavoured to do the advance of sanitation for the protection of the population on the sea, and also for the protection of moving populations on land, although we may not at present develop district normas specially applicable to them, as in the instances of the Army and Royal Navy, yet we have established the power of giving full protection to those moving populations, and of advancing the security of transit and the freedom of trade. To this end it is proved that steps may be taken to remove the remaining obstructions created by reactionism on false and pernicious hypotheses.

(*To be continued.*)

An International Exhibition, under the patronage of H.R.H. Prince Humbert, and organised by a National Committee, is to be held at Milan in 1879. The municipality have granted the use of a site for the building, with open-air space for an agricultural department.

THE TELEPHONE.

The accompanying illustration, re-produced from the *Engineer* by permission of the proprietors of that paper, shows the Telephone of the full size of which the instrument is usually constructed. A is the diaphragm of sheet iron. Ferrotype plate is generally used, but ordinary "tin-plate" answers as well. B is the coil of fine wire, ·010 to ·005 of an inch. The length is such as to give a resistance of about 70 ohms. The soft iron pole



piece, E, screws into the somewhat thicker permanent magnet, C. The magnet is supported at its ends by the screw, D, which screws in a hole tapped in the magnet, so as to enable the distances between the pole and the diaphragm to be adjusted. In some instruments a spring is fitted, to bring the magnet forward when the screw is loosened.

In the engraving the magnet is represented as octagonal, but this is immaterial, some of the best instruments having been constructed with compound magnets.

PHILADELPHIA EXHIBITION REPORTS.

(*Continued from Vol.* xxv., *p.* 1018.)

Architecture and Engineering.

Sir John Hawkshaw, in his report on this subject, treats of some of the most important recent engineering works executed in America, instead of merely referring to the plans, descriptions, &c., actually shown at Philadelphia. He notices that England was very poorly represented, but that some countries in which the public works were more under the control and supervision of the Government, such as Holland, contributed to a greater extent.

The operations at Hell-gate, for clearing the entrance to New York Harbour, are the first mentioned, and as they are the most important of any recently undertaken, so a considerable part of the not very extensive report is given up to a description of them. Amongst other works in progress or recently completed, are those for improving the entrance to the Mississippi, the harbour of refuge on Lake Huron, several lighthouses, and some important bridges spanning the vast rivers of the continent. The extent of coast to be protected by lighthouses amounts to 5,000 miles. In 1875 there were under the charge of the U.S. Lighthouse Board 639 lighthouses and 23 lightships.

The extent of the engineering works completed since Sir John Hawkshaw's last visit to America many years ago, struck him with astonishment, and, in his own words, "impressed me very strongly with the energy of the people, and the resources of this great country."

Plastic and Graphic Art.

Mr. Cope found that the most extensive collection of pictures was, as might have been expected, that contributed by the United States. In this collection was an almost puzzling variety of aim and treatment. It was evident that the artists had studied in European schools, and had brought home not only French, Belgian or English taste and methods, but even a tendency to European rather than national subjects. The most original and interesting efforts belonged to the branch of landscape painting, though Mr. Cope criticises somewhat severely the style of many of the pictures representing the grand scenery of the far West.

The French school of painting was inadequately represented, but this was atoned for by the sculptors, of whose work Mr. Cope speaks in terms of high commendation. The Italian sculptures were numerous, but unsatisfactory. The art of etching was well represented by exhibits from France, England, Austria, and America. Line engravings were scarce, and it was evident that the numerous and excellent photographic processes are elbowing out of existence such arts as that of line engraving. As regards the British collection, Mr. Cope says:—"It seems to be universally conceded that among the various nations which have contributed works of Fine Art, England stands conspicuously and honourably prominent." This generally expressed opinion is confirmed by the verdict of most of the foreign as well as the American judges.

Industrial and Architectural Designs, &c.

The late Mr. Peter Graham was the reporter for this group, which included "Industrial and architectural designs, models, and decorations, decoration with keramic and vitreous materials, mosaic and inlaid work." Very few "Industrial designs" were exhibited, and those of small merit. The "Architectural designs" were much more numerous and meritorious. After the United States, Great Britain, Austria and Spain, took prominent places. The examples of "Decoration of interiors of buildings" were neither numerous or important, the best being the interior of the houses of the British Commission. The specimens of "Artistic hardware and trimmings, artistic castings, forged metal, work for decoration, &c.," exhibited by manufacturers of the United States, were numerous, and many of them in good taste. The largest and most important exhibition of decorative metal-work was from Great Britain, and many of the objects are described as being "in very pure taste and of perfect execution." The prevailing style was mediæval or early English, and ecclesiastical. The "Mosaic and inlaid work in stone" was nearly all from Italy. Sweden and Russia also sent specimens which received commendation. In the class devoted to "Mosaic and inlaid work in tiles, tesseræ, glass, &c.," there were few exhibitors, and no medals were awarded.

Among the exhibits of "Inlaid work in wood and metal, parquetrie inlaid floors, tables, &c.," the largest number came from Japan, and the objects were, many of them, highly commended. The finest specimen of parquetrie was from Belgium. The Japanese also showed some remarkable specimens of inlaid metal work. In the "Stained glass" class there were many exhibitors, and the specimens showed great progress.

Education.

Sir Charles Reed found that the educational section of the Exhibition was confined within somewhat narrow limits. Little or nothing was sent by Great Britain and her colonies (Canada excepted), by France, Germany, Norway, Austria, Italy, or Brazil, except maps, school books, and general publications. The countries that were best represented were the United States, Canada, Sweden, Belgium, the Netherlands, Switzerland, Spain, Russia, Japan, and the Argentine Republic. Most of these exhibits consisted of school appliances and apparatus for instruction. Russia showed many illustrations of the Russian system of technical education, a collection for instruction in working ing metal from the St. Petersburg Practical Technological Institute; samples of work done by the pupils of the Strogonoff School of Technical Drawing at Moscow; models and specimens of work from the Imperial Technical School at Moscow. The Japanese have been making, during the last few years, very remarkable progress in education. They have sent visitors to inspect and report on English and other schools; they have drawn up a code; and have assigned a sum of £400,000 for purposes of public instruction. The exhibits at Philadelphia fully illustrated the system now adopted, and drew expressions of warm praise from some of the visitors. After noticing the foreign exhibits, Sir Charles Reed passes to those of the States themselves. To ensure a good representation at the Exhibition considerable pains had been taken. Each State was authorised to appoint a commission, a certain sum being voted for the purpose of enabling it to send up a collective exhibit of statistics, literature, and students' work. As most of the States responded, the result was a very complete illustration of the present condition of education in America.

Out of the 3,250,000 square miles included in the Union, 2,265,625 are public land. Of this public land one-sixteenth has been set apart for educational purposes, and is called the "School Lot." In most cases the land has been sold, and the proceeds invested, giving, with endowments, an annual sum of 5,175,166 dols. State and local taxation affords 58,855,507 dols. more, and there are also special funds, amounting to 2,000,000 dols. There are no school fees, but it appears that there is much difference of opinion as to the wisdom of this arrangement.

The New England Schools are the best, as they are the oldest, but nearly all the States have made great progress during the last ten years. In some of the Southern States, indeed, but small progress has yet been made. In Texas the system is said to be "struggling with every conceivable difficulty." In nine States

school attendance is compulsory, but the rule even in these is only of recent introduction, and its results are "not wholly satisfactory." Sir Charles Reed thinks that the coloured schools promise good results, and he speaks of successes at Yale and Harvard as attesting the abilities of some young men of colour. To show the ideas now working in the minds of children born in slavery, some extracts from themes are given, written by children, and having for their subject the "Advantages of education." It is needless to say that these are of the crudest nature. North of Washington mixed schools are found, south of that City the sexes are taught separately, and this is attributed to prejudices of colour.

The question of procuring suitable teachers presents various difficulties. The payment is small, and not sufficient to induce those who take up the business to regard it as more than a stepping stone to some more lucrative position. Female teachers preponderate, and they leave this business when they get married. In Louisiana a law has been passed by which women are to receive the same payment as men, in the hope that the practice may thus be checked of bidding for cheap teachers.

The good order and discipline of the schools visited struck those who inspected them. The range of subjects in primary schools is no wider than our own. The difficulties of English spelling have attracted notice beyond the Atlantic as here, and a Commission has been appointed to consider the advisability of an amended orthography. The system apparently most in favour is "Leigh's method," in which different characters of type are used to express the different sounds of letters, *e.g.*, letters not sounded are printed in "hair-line," or light-faced type. It is stated that children taught by this method get through two years' ordinary work in a single year. Sir Charles Reed next makes some remarks on the teaching of writing, gymnastics, drawing, needlework, natural science, &c., most of which subjects appear to be well and effectively taught. Of the work in secondary and higher schools some good examples were shown. Schools of this class are much better supplied with apparatus for instruction, but Sir Charles Reed seems to think that these schools run a risk of superficiality, from the large range of subjects taught. A sort of voluntary normal school is spoken of, which consists of an association of teachers, meeting for a few weeks in their holidays, and forming classes for study of the subjects they are engaged in teaching.

"From all parts of the Union comes testimony in favour of technical education, and a desire for its development." The principal institution for the purpose is the Massachusetts Institute of Technology, at Boston, founded in 1862. Closely following this are the Industrial University of Illinois, Cornell University, and the Worcester Industrial Institute. The advance that has been made in the matter of school buildings was strikingly illustrated by the exhibition of an actual building, built and furnished precisely in the fashion of a school of a hundred years ago. Now, with exceptions in the country districts, "most of the new schools may be said to be thoroughly good." The internal fittings are praised, and the bright, cheerful appearance referred to in terms of approval.

In conclusion, Sir Charles Reed says that "America has reaped the advantages of education in the quickened intellect, widely-diffused information, general sobriety, and trained mechanical skill of her citizens. This it is that has supported her in every department of commerce and art, and given backbone and fibre to her national life. . . . On the whole, England has nothing to fear in fair competition with America. Visitors from the States admit our schools in the large towns to be on a level with theirs, and are as anxious to learn from us as we should be to copy the excellencies of their system. Towards enabling us to do this, the Centennial Exhibition at Philadelphia has rendered valuable service."

OBITUARY.

Mr. Sydney Smirke, R.A., died on the 8th inst., in the 79th year of his age. He was brought up in the office of his brother, Sir Robert, and inherited the same taste for classical architecture. He was treasurer of the Royal Academy. Under the inspiration of Sir A. Panizzi, when principal Librarian of the British Museum, he designed and erected the reading-room of that establishment. The Carlton Club in Pall mall was erected by him, its principal proportions and decorative features being adapted from Sansovino's Libreria at Venice. He also executed one or more other club-houses in Pall-mall and many private edifices. The arrangements of the Exhibition rooms of the Royal Academy are due to him. Mr. Smirke became a member of this Society as far back as 1847, and in 1863 he was elected on the Council.

GENERAL NOTES.

Proposed Australian Exhibition.—Australian papers state that arrangements are in progress for the International Exhibition proposed to be held at Melbourne in 1879, and the scheme has the approval of the Legislative Assembly. The Governor, speaking recently at Stawell, said that the proposal could not fairly be described in any quarter as premature, if regard were had to the wonderful progress which the Australian Colonies have already acheived. In 1879 the aggregate public revenue of the several Australian Colonies will exceeed 16 millions sterling, while their trade, including exports and imports, will amount to nearly 90 millions in value. In other words, Australasia, as a whole, could take her place among the 10 or 12 great nations of the world in point of the value of their trade and general importance, for there are only seven or eight nations with a larger public revenue than 16 millions. The three powerful colonies of Victoria, New South Wales, and New Zealand, have each a revenue and trade which would place them on a higher scale than ancient European kingdoms like Sweden, Denmark, and Saxony. The single colony of Victoria, with its yearly revenue of $4\frac{1}{4}$ millions, is already equal in wealth and importance to the kingdom of Portugal, while Melbourne is considerably above Lisbon in wealth and trade. The success of the Exhibition, he pointed out, would depend in a great measure upon the cordial co-operation of the mother country and the sister colonies of Australasia. His Excellency further stated that he was in correspondence with the Secretary of State for the Colonies, who was anxious to give every possible assistance, and that the presence of the Prince of Wales was all that was needed to render the Exhibition a triumphant success. He expressed himself confident that his Royal Highness, if invited by both Houses of Parliament, might be induced to come out to open the Exhibition, and he was certain he would be received with enthusiasm.

NOTICES.

MEETINGS FOR THE ENSUING WEEK.

Thur....Royal Institution, Albemarle-street, W., 3 p.m. Prof. Tyndall, "Heat, Visible and Invisible." (Lecture I.) (Juvenile Lectures.)
London Institution, Finsbury-circus, E.C., 7 p.m. Prof. W. E. Barrett, "The Telephone."

Fri.......Quekett, University College, Gower-street, W.C., 8 p.m. Mr. Marcus M. Hartog, "The Investigation of Floral Development."

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,310. Vol. XXVI.

FRIDAY, DECEMBER 28, 1877.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

JUVENILE LECTURES.

A course of two Lectures, adapted for a juvenile audience, on "Coal and its Components," will be delivered by Prof. Barff, on Wednesday, January 2nd, and Wednesday, January 9th, at seven o'clock. As the number of seats is limited, admission will be by ticket only, and when sufficient tickets have been issued to fill the room, the issue will be discontinued. The tickets will be supplied strictly in the order in which the applications are received. Subject to these conditions, each member is entitled to a ticket admitting two children and one adult. Tickets can now be obtained by members on application to the Secretary.

NATIONAL TRAINING SCHOOL FOR MUSIC.

The competition for the Novello Scholarship was held at the National Training School for Music, on Wednesday, the 19th inst. The examiners were Mr. Joseph Barnby, Dr. Arthur Sullivan (principal of the school), Dr. Stainer, and Mr. Alberto Visetti. There were seven candidates. The scholarship was awarded to James Farquharson Walenn. At the same time Miss Charlotte E. Cobb was elected out of seven candidates to the vacant scholarship of the Clothworkers' Company.

CANTOR LECTURES.

THE TECHNOLOGY OF THE PAPER TRADE.

By William Arnot, F.L.S., Edinburgh.

Lecture II.—Delivered December 8th, 1877.

Raw Fibrous Materials, their Characteristics and Treatment preparatory to Pulping.

The materials which have, at one time or another, been experimented upon, with the view of converting them into paper, may certainly be counted by hundreds. Very many vegetable substances have, indeed, been manufactured into paper, but comparatively few of them have been found to yield satisfactory commercial results. The scarcity of the material itself, the low per-centage yield of fibre, or the difficulty of disintegrating and bleaching it, have put scores of what appeared promising substances entirely out of competition.

The necessity of supplementing our rag supply by other fibre-yielding substances early engaged the attention of manufacturers. We find that, more than a century ago, many varieties of wood, leaves, straws, stems, roots, peat, and other substances, had been experimented upon, and, in most cases, reasonably good paper made from them. Some interesting historical records of those experiments exist, and among them we may mention a book published in 1772, containing specimens of paper made from 60 different substances. A copy of this book may be seen in the British Museum. It is not, however, our province to enter into an examination of the records referred to, but I cannot help mentioning the names of Jacob Christian Schaeffer and Matthias Koops, who, at a very early date, threw an excellent spirit of inquiry into the problem, and were rewarded with what we must consider very great success indeed. Another name which ought to be mentioned in this connection is that of Mr. Thos. Routledge, to whom undoubtedly belongs the credit of introducing esparto grass, and who is at present striving to introduce another new and, as he believes—nor is anyone more qualified to judge—better material.

Pure white unsized and unloaded paper may be said to be pure cellulose. The mechanical or physical condition in which this substance exists is undoubtedly of more interest to the paper-maker than its chemical constitution. Seeing, however, that it is the basis of all vegetable fibres, and is liable to be affected by the chemicals employed in the process of preparation, we must give some little attention to its chemical history.

Pure cellulose is a white, translucent solid, half as heavy again as water, in which, as in alcohol and oils, it is insoluble. The elements of which cellulose is built up are carbon, hydrogen, and oxygen, in the proportion of 6, 10, and 5 equivalents respectively. Centesimally represented, it would be carbon, 44·45; hydrogen, 6·17; and oxygen, 49·38.

Cellulose is found in various states of aggregation in the vegetable world, ranging from the gelatinous condition of Iceland moss to the horny condition of vegetable ivory, nut shells, seeds, and such like. It is almost invariably associated with extractive and other matters, which must be removed by chemical treatment if the cellulose is wanted pure. Potash and soda will remove the resinous and extractive matters, and hydrochloric acid the mineral constituents, copious washings being employed after each treatment.

Strong sulphuric acid converts cellulose into dextrine, which, though physically very different from cellulose, is identical in chemical constitution, and is, therefore, said to be isomeric with it. Boiled with water this dextrine is converted into glucose or fruit sugar. Strips of paper or linen can thus be converted into sugar.

Strong boiling hydrochloric acid converts cellulose into a fine powder without changing its composition, while strong nitric acid produces nitro-substitution-products of various degrees corresponding to the strength of the acid used.

Chlorine gas passed into water in which cellulose is suspended rapidly oxidises and destroys it, and the same effect takes place when hypochlorites—such as hypochlorite of calcium or bleaching liquors—are gently treated with it. It is not therefore the cellulose itself which we want the bleaching liquor to operate upon, but only the colouring matters associated with it, and care must be taken to secure that the action intended for the extraneous substances alone does not extend to the fibre itself.

Caustic soda or potash affects but slightly cellulose in the form in which we have to do with it, but in certain less compact conditions these agents decompose or destroy it.

An ammoniacal solution of oxide of copper dissolves cellulose completely, while an excess of hydrochloric acid added to the solution precipitates it in amorphous flakes.

These are the principal features in the chemical history of this substance, and it will be well that they should be borne in mind, as, every now and again, we have new processes for treating vegetable fibres brought before us, many of which are founded upon principles entirely at variance with chemical facts.

The physical condition of cellulose after it has been freed from extraneous matters by boiling, bleaching, and washing, is, as already indicated, of great importance to the manufacturer. Some fibres are short, hard, and of polished exterior, while others are long, flexible, and barbed; the former, it is scarcely necessary to say, yielded but indifferent papers, easily broken or torn, while the papers produced from the latter class of fibres are possessed of a great degree of strength and flexibility.

Fibres from straw, and from many varieties of wood, may be taken as representatives of the former class, those from hemp and flax affording good illustrations of the latter. There are, of course, between these two extremes, all degrees and combinations of the various characteristics indicated.

It will be readily understood that hard acicular fibres do not felt well, there being no intertwining or adhesion of the various particles, and the paper produced is friable. On the other hand, long, flexible, elastic fibres, even though comparatively smooth on their exterior, intertwine readily, and felt into a strong, tough sheet.

We shall look briefly at some of the leading and representative fibres from this point of view.

Cotton fibre is long and tubular, and has this peculiarity, that when dry the tubes collapse and twist on their axis, this property greatly assisting the adhesion of the particles in the process of paper making. In the process of dyeing cotton the colouring matter is absorbed into the tubes, and is, as will be readily appreciated, difficult of removal therefrom. Papers made exclusively of cotton fibre are strong and flexible, but have a certain sponginess about them, which papers made from linen fibre do not possess.

Linen is the cellulose of the flax plant, and before it reaches the paper maker the extraneous matters have been removed by steeping or retting, boiling and bleaching, consequently it requires but little chemical treatment at his hands. Linen fibre is, like cotton, tubular, but the walls of the tubes are somewhat thicker, and are jointed or notched, like a cane or rush. The notches assist greatly in the adhesion of the fibres one to another. This fibre possesses the other valuable properties of length, strength, and flexibility, and the latter property is increased when the walls of the tubes are crushed together under the action of the beating engine. From this fibre a very strong compactly felted paper is made; indeed, no better material than this can be had for the production of a first-class paper.

Ropes, coarse bags, and such like are made from hemp, the cellulose or fibre of which is not unlike that of flax, only it is of a stronger, coarser nature. Manilla yields the strongest of all fibres. Jute, which is the fibre, or inside bark, of an Indian plant, yields a strong fibre, but is very difficult to bleach white.

Esparto fibre, which is now so extensively used, holds an intermediate place between the fibres I have just described and those of wood and straw, to which I am about to refer.

The fibre of straw is short, pointed, and polished, and cannot of itself make a strong or flexible paper.

The nature of wood fibre depends, as may readily be supposed, upon the nature of the wood itself. Yellow pine, for example, yields a fibre long, soft, and flexible, in fact, very like cotton; while ash and many other woods yield short, acicular fibres, which, unless perfectly free from extraneous matters, possess no flexibility, and, in any case, are not elastic.

This is a field requiring further study and investigation, as little reliable information of a really scientific character can be readily reached. The manufacturer can tell you the character of his fibres from the character of the paper which he produces from them, but we want to be able to say what kind of paper will be produced from a given fibre, from our knowledge of the characteristics of the fibre itself. The microscope has here a thoroughly practical field to investigate. Much of a desultory character has no doubt been done by others as well as by myself, but I am not aware that any systematic and exhaustive study of the subject has been attempted.

I have been favourably impressed with the appearance of the fibre obtained from bamboo stems, which is the material upon which Mr. Routledge is at present working. The bleached paper stock has a close resemblance to linen stock, although by no means possessing the strength of linen. That we have in bamboo an abundant source of high-class vegetable fibre, there is little doubt; that it can be dealt with so as to make it commercially available to British paper-makers, is the practical question to which Mr. Routledge is devoting his attention.

We will now proceed to inquire into the treatment of the various raw materials from which fibre or cellulose is extracted in the process of paper making.

The operations of cutting and sorting rags are sometimes preceded by a preliminary dusting or thrashing, to remove the grosser portions of the sand and dust, and this certainly renders the cutting and sorting more agreeable operations than they are when done without any previous dusting. The objects and *modus operandi* of cutting and sorting

have already been described. The cutting is occasionally done by a machine, but, unless in the case of very coarse materials, hand-cutting is preferable. There is a smaller loss of fibre by the hand process, and, as may be readily supposed, the picking and sorting can be more surely accomplished. The hand-cutting knife is a simple blade fastened to the table, and inclined so that the free end rests against the person of the cutter. The sizes to which rags are cut vary, in different mills, from 2 in. to 6 in. square, or thereabout. They are generally very carefully sorted into classes, and it is certainly desirable that they should be so, as the finer the rags are, the less boiling and bleaching they require to render them quite white; and the coarser and more impure they are, the more boiling and bleaching is necessary; and when both fine and coarse are mixed, the fine portion will be overdone in both processes before the coarse has been sufficiently treated. In practice, rags are generally sorted into two classes as to material, four classes as to texture, and into three or four as to colour. The cut and sorted rags are next put through what is known as a willow and duster, of which there are various modifications. One of the best forms of the willowing portion of the machine used in this country consists of two spiked drums revolving in opposite directions at the rate of 250 revolutions per minute. The rags are fed steadily into the willow, where they are thoroughly thrashed or beaten, and afterwards pass into the duster. This is simply a revolving wire cage or screen, with blades or leaves of wood projecting inwards a few inches. The duster makes from twelve to fifteen revolutions per minute, and is set at such an inclination as will insure the rags being thoroughly freed from dust before being discharged at the lower end. Of course these machines are enclosed, as nearly as possible, dust-tight, and the dust accumulates in receptacles below, from which it is removed from time to time. The rags, as they fall from the duster, are taken direct to the boilers, where we shall leave them for the present.

In the case of materials such as esparto and straw, the bunches are opened out and spread upon a table of open wirework, the dust shaken out, and all roots and other extraneous matters removed. The picked materials are put into bags, and, without any further treatment, taken to the boilers. Sometimes in preparing straw for the boiling process, it is cut into short lengths, to facilitate the stowing of it into the boilers; it is naturally so bulky that, in order to get a full supply in, some such plan is necessary. Machinery similar to the well-known thrashing mill has been introduced for the purpose of cleaning and dressing esparto. Some very effective work has been done by it, and that at a considerable saving as compared with hand-picking, and we doubt not that, by-and-bye, the use of such machines will become general.

Wood is cut into chips of various degrees of thinness—the average being about half an inch—by machines of which quite a variety have been invented for the purpose. Before being fed into the boilers, the chips are sometimes bruised or disintegrated in a bark mill or similar appliance. Poplar is recognised as one of the most suitable woods for paper-making, and, with the view of meeting the demands of the future, Mr. Young, so well known as a friend of science and the successful manufacture of paraffin, sometime ago planted many square miles of poplars on Deeside, in Aberdeenshire. Unfortunately, either the soil or the climate has proved unsuitable for the culture of this tree, and large numbers of those planted have died out. Many other woods, however, are suitable and available for the making of paper, and in Sweden log and batten ends of all kinds are chopped up for this purpose.

The raw materials having been, as far as possible, freed from mechanical impurities, we have now to subject them to the highly important process of boiling, in which, by the aid of a powerful chemical agent, the chemical impurities are rendered soluble, or, failing this, made more easy of removal in the washing process which follows. The boiling operation is conducted in a steam-tight vessel, of which there are various forms, and the necessary heat is obtained from steam variously applied. Caustic soda is now almost exclusively employed as the chemical agent, and we purpose in a subsequent lecture to consider particularly, along with other chemicals, its nature, valuation, and recovery. For our present purpose it will be sufficient that we clearly understand that caustic soda is one of the most powerful alkaline substances, and being uncombined, it greedily seizes and combines with even feebly acid vegetable substances, while its action as a solvent is also powerful.

The work which the boiling caustic soda solution performs in the case of rags is the extraction of fatty, glutinous, and colouring matters; with some of these substances it combines to form soaps, some it decomposes, and others are dissolved by its agency. It has also a softening action on the fabric of the rags, which renders the disintegration of them in the after processes more easy of accomplishment.

In America, rags are frequently treated with caustic lime instead of caustic soda, but this is not done to any considerable extent in this country. The two agents are also sometimes used together. Hofmann, in his work on paper-making, advocates the use of lime in preference to soda for the preparation of rags, and seems to make out a fair case in favour of the former. Although lime is only very sparingly soluble in water, its action is evidently considerable, owing to the ready absorption of that portion of it which is in solution by the fatty and other impurities in the rags, and the immediate solution of more, which in turn is also absorbed. This solution and absorption may go on continuously and rapidly, and the desired effect be accomplished much more speedily than we could anticipate, judging from the circumstance of the comparative insolubility of the agent. Some colours are not removed by lime, however, and I suspect that in this country grave objection would be made to the discharge of waste lime liquor into our streams, as, unlike soda liquors, they could not be profitably evaporated. I think, too, that the amount of gritty matters, as well as the excess of lime left amongst the rags, would be objectionable, and involve much additional washing.

Upon raw fibrous substances, strictly so called, the action of caustic soda in removing the oily, resinous or gummy, and silicious matters, and promoting the disintegration of the mass, is the one thing which has rendered the use of almost all

our vegetable stems and leaves possible. A plant might consist largely of the strongest and most desirable of fibres, and yet be quite useless to the paper maker, if he had not some ready and effectual means of removing the substances which either coat its exterior or cement the various fibres into one hard, compact mass. The cells of which the cellulose or fibre forms the walls are generally encased in a thin covering of what is called lignine —a substance differing somewhat in physical properties, but of the same chemical constitution as cellulose. The lignine-coated cells, again, are closely packed and cemented together with various substances, sometimes waxy, sometimes gummy, and sometimes resinous, and the whole is often covered with a waterproof coating of silica, as in the case of straw, esparto, and cane.

Caustic soda, in strong solution and at a high temperature, readily dissolves the silicious scale, forming a well-defined chemical compound known as silicate of soda. It further combines with the resinous matters, forming compounds which may be generally regarded as resinates of soda, or resin soaps, while with oils and fats other soaps are readily formed. The bonds which held the cells or fibres so firmly together are thus broken, and the fibres are free to separate when subjected to the necessary mechanical processes. It is thus evident that the process of treatment called "boiling" is one demanding careful study. The caustic soda, too, is an expensive agent, and economy in its use is therefore of the highest importance.

The boilers may be either stationary or rotary, deep or shallow, cast or malleable, of capacity measurable by cwts. or by tons, high pressure or low pressure, so diverse are the arrangements in practice in all of these particulars. There are good working and bad working boilers of all these classes. What has to be aimed at in boiling is thoroughness and uniformity, accomplished in the shortest possible time, with the smallest expenditure of soda and steam. All the excellencies are not necessarily confined to one class of boiler, and our experience goes to show that the boiler must be very bad indeed if, with some alterations in its internal arrangements and proper management, it cannot be got to do fairly good work. No doubt a large, well proportioned, and well constructed boiler, working under high pressure, is in its nature calculated to do proportionately more and better work than a small one of the ordinary low pressure type. The gallons of soda solution or ley per cwt. will be less in the former than the latter, taking it for granted, of course, that they have been equally well packed, and, as a consequence of this, the material will be either quicker and better boiled or the work will be done with less soda per cwt.

For esparto a stationary boiler is always to be preferred, while, in the case of rags, there is some evidence to show that a good rotary does yield results which compare favourably with even the best stationary.

Of the many forms of stationary boilers, patented and unpatented, I prefer what is known as the "vomiter," which for all ordinary purposes may be made of cast iron, but, if intended for very high pressure, is usually made of malleable plates like a steam boiler. A convenient size is nine feet six inches wide by five feet deep, and capable of boiling two tons of esparto grass. It is fitted with a perforated false bottom, with as little space below as possible. In the centre of the boiler is placed a rather wide vertical tube open at both ends, the upper end being enlarged like an inverted bell, and covered at a distance of a few inches by a plate, or "bonnet" as it is called. At the bottom of this wide tube is the orifice of the steam-pipe, which usually discharges upwards, but it is sometimes carried down through the cover of the boiler, and made to discharge at a distance of an inch or two from the bottom. When the boiler is charged with its complement of rags, or esparto, soda and water, and the man-lid closed, the steam discharged at the foot of the wide tube rushes upwards, carrying the soda liquor with it, and the liquor striking with some violence upon the underside of the "bonnet" discharges umbrella-like all over the surface of the raw material. This action continuing speedily empties the space beneath the false bottom, thereby forming a partial vacuum and inducing a powerful downward current through the material in process of being boiled. No sooner does the ley get below the false bottom again than it is sucked up and discharged again over the top. Such is the general action of this boiler, the principle involved being the same as that of the ordinary blower or injector, which lifts water from a well or forces it into a steam boiler under pressure. In filling such a boiler as I have described with, say, esparto, care must be taken to get as large a quantity in as possible, and this can be best accomplished by setting the "vomiter" to work after as much has been got in as conveniently can. The lid may or may not be closed, and after a time it will be found that the grass has been reduced in bulk considerably, so that a further quantity may be added. After a little time, and a repetition of the same process as before there will be room for another supply, and so on until the full complement has been got in.

Patent covers of one description and another have been devised for the purpose of putting pressure on the grass to reduce its bulk in the boiler. I do not think the object a good one; the grass, while in the process of boiling, should not be squeezed together further than by its own weight, for, if subjected to additional pressure, some portions are sure to get so closely compact that it is with difficulty the soda can get through them, and the result is want of uniformity in the product.

In charging the boiler the soda is put in first, and dissolved in the water, which is added before the grass is introduced, this being a much more satisfactory method of procedure than that which used to be pretty generally adopted, viz., putting in the soda in solid lumps on the top of the grass. Soda takes some little time to dissolve, and, doubtless, the action of the solid soda or of the highly concentrated solution draining from it would be detrimental to those portions of the charge coming under its immediate influence. The practice as to using 60 or 70 per cent. caustic soda varies; one paper-maker tells us he cannot boil his grass soft with 60 and is obliged to use 70; another laughs at such an idea, and boils well with as many pounds of 60 as his neighbour uses of 70. Now I believe that no one need use 70 per cent. for boiling either esparto or straw; it is propor-

tionately more expensive, and undoubtedly points to a screw being loose somewhere when it is found that 60 per cent. soda cannot do the work. Again, some people say they can boil Oran, or African grass, which is coarser than Spanish and requires more soda, with $15\frac{1}{2}$ lbs. of 60 per cent. caustic, while others cannot boil Spanish with less than 17 lbs. per cwt. No doubt the pressure under which the boilers are worked has something to do with this diversity of opinion and experience; no doubt also many makers consider grass well boiled which others would consider hard. We believe that very much depends upon the amount of solution per cwt. which one maker can manage to work with as compared with another. The stronger the solution the better the work will be done, as there is always an excess of soda used: if it is kept well concentrated it will do its work well, whereas, if it is much diluted, it will as certainly do its work indifferently. This question of the strength of the soda solution has also a powerful bearing upon the question of time of boiling, and is one of a series of circumstances which determine whether one or two charges can be got out of a boiler per twenty-four hours. In practice we have both extremes; and it is quite obvious that he who can take two charges out of his boilers in twenty-four hours can do with one-half of the plant that another taking only one charge in the same time must require.

Before considering the boiling process, as conducted in revolving boilers, we shall look into the further treatment of esparto, and similar raw materials, in stationary boilers. The boiling having been completed, the spent soda ley is run off, and, for the sake of the profit to be made, as well as with a view to the conservation of the purity of rivers, evaporated. With the evaporation process we shall have more to do by-and-bye. Meantime, we must consider the cooling of the charge. This is usually done by simply filling up the boilers with cold water, and allowing the whole to stand quiescent for a few hours before running it off. When the "coolings," as they are sometimes called, are not permitted to be run into the stream, they are used for causticising the recovered soda, or for dissolving the fresh caustic soda and re-furnishing the boilers. Most of the millowners in Scotland have to do this, and in some cases still further pressure is put upon them. I have recently proposed a system of treating esparto, which I have found to give entirely satisfactory results alike to the papermaker and riparian proprietor. The boilers are filled three times in succession: 1st, with "boilings;" 2nd, with what I propose calling "second boilings," and third with "coolings" properly so-called. The "coolings" ultimately become "second boilings," and the second boiling "boilings;" there is thus but one volume of liquid to evaporate, and a considerable additional strength is given to that volume, so that the recovery process is rendered more remunerative. The wet picking is more easily and effectively accomplished, and as a result, cleaner paper is produced. The washing is also reduced to one-half, with a consequent saving of $1\frac{1}{2}$ per cent. of fibre, and a material reduction in the amount of polluting matters going to the stream. The actual working of the process is as follows:—The "boilings," or spent soda liquor, having been drained off, the boilers are filled up with the "coolings" of previous batches, and steam turned on until the whole reaches the boiling point. It is then shut off, and quiescence maintained for four hours; one half of the "second boilings" are then run off, the other half is kept in the boiler for two hours longer and then run off too. The liquid thus drained off in two portions is used for causticising the soda recovered from the "boilings," and goes back to the boilers as fresh ley. The boilers are finally filled up with clean cold water and allowed to stand for four hours, when one half is drained off and the remainder or second half is allowed to stand other two hours, when it too is drained off as before. As already indicated, the "coolings" thus run off are used for the "second boilings" of the succeeding batch. The process is based upon well ascertained principles, and the results are satisfactory. During the periods of quiescence referred to, the heavy black liquid in the stems of the grass is displaced, partly by endosmotic action and partly by gravitation, by the heavier surrounding fluid. The heavy displaced liquor sinks to the lower part of the boiler, so that when it is run off the lighter and purer liquor from above gets down to the grass below, which still retains much impurity, but this is largely displaced during the succeeding two hours' rest.

I am aware that the same principle has been much more elaborately applied, but there are few manufacturers who can afford such a complicated and extensive plant as is required for the carrying out of such schemes. Even for the process I just described, about one-third more boiler power is required, but wherever there is a serious river question or a desire for improved results, both in per-centage, out-turn, and quality, the additional plant required cannot be considered a serious matter. Of course, where there is no river difficulty the simplest treatment, with a view to economical results, would be to evaporate the "boilings," and bathe the grass with clean water as often and as long as possible, running the bathings to waste each time.

With the view of still further obviating the pollution of the Esk, the paper-makers there, some time ago, adopted a system of squeezing their esparto after it was taken from the boilers, the purpose being to press out the residual soda liquor which was also evaporated. The squeezer consists of a pair of metal rollers covered with cocoa yarn, with suitable feeding and discharging bands. This system has, however, been almost entirely abandoned, owing to the little good which it did to the stream, the irregularity of the work done by it, and the considerable expense involved. Various bathing systems have been adopted instead, with improved results in every way.

Revolving boilers, I have said, are not suited for esparto. This class of raw material suffers from being knocked about while in process of being boiled, as it gets broken up in such a way that the wet picking is seriously interfered with. Rags do not suffer in the same way; some portions, it is true, get rolled up into little balls, but notwithstanding this, they seem to take well to the rotating process. A considerable share of the work done in the boiling of rags is the extraction of mechanical dirt from the interstices of the fabric, and the motion of the rotary seems to help to wash that out.

Revolving, like stationary, boilers are manifold in form as well as in detail; some are spherical while others are cylindrical, and the axis of the latter again may be either horizontal or diagonal. It is really difficult to see wherein lie all the advantages claimed for the various designs; what is wanted, however, is just what I have pointed out as requisite to the successful working of the vomiter, viz., to get as much raw material into as small a volume as possible without unduly compressing it. Just as you succeed in this you get your work done quickly and cheaply.

The proportion of caustic soda used with rags varies according to their quality and purity, ranging from one or two to ten or twelve pounds per cwt.

The boiled rags or esparto, as the case may be, are drawn or emptied from the boiler after the cooling has been properly effected. The boxes into which the boiled material is put generally hold two cwt., and are placed on wheels for convenience of transit. Before going to the washing and breaking engine, the picking process is repeated, the boiling having brought to view many impurities which escaped the eye in the previous examination, and it is now the duty of the pickers to remove these, so that the pulp about to be produced may, as far as possible, be uncontaminated with hard or unbleachable particles.

Wood pulp boilers, and, indeed, the whole wood pulp process, have undergone a very satisfactory development in recent years. One of the most satisfactory of the many patented processes is that known as "Sinclair's," and, as I am familiar with the details of this system, and satisfied with the thoroughness of the work done by it, I shall describe it as representing an almost perfect system. Mr. Sinclair's patents apply to the wood boiler, and to the steam generator connected therewith. The operation of pulping, however, begins with the preparation of the timber on the saw bench, the work of the saw being to put the rough material into shape for the slicing or cutting machine. This machine slices the wood diagonally with the grain, thus facilitating the bruising or disintegrating process which follows. The wood is raised by an elevator to the hopper of a bark-mill, from which, after being bruised, it discharges into the pit of another elevator which lifts it to the flat above, where it is on a level with the mouth of the boiler. The boilers, which are about 4 ft. diameter, and 18 or 20 ft. deep, and of great strength, are charged with 25 cwt. of the wood thus prepared. Along with a due proportion of water, just sufficient to cover the wood but no more, caustic soda, in the proportion of 26 to 28 lbs. per cwt., is introduced. Before the steam is turned on to the wood pulp boiler at all, it is got up in a patent generator to something like 300 lbs. pressure. When the valve between the generator and the boiler is opened, the pressure in the former rapidly falls to about 200 lbs.; in about two hours the soda liquor and wood have attained a corresponding temperature—about 380° F.—which is maintained for three hours more, when the valve is closed, and the pressure in the boiler reduced to about 100 lbs. by opening an escape valve at the top. The steam so escaping is utilised in heating the water used in the hydro-extractors to be presently referred to. When the desired reduction in pressure in the boilers has taken place, the escape valve is closed, and the discharge valve opened, when the remaining pressure forces the whole contents of the boiler into an adjoining cistern which is fitted with an agitator. From this, the stuff is delivered in successive batches through a sieve into centrifugal machines, or hydro-extractors, when the ley is first expelled, after which hot water is introduced, so as to wash the pulped wood quite clean. The product is very beautiful, the resin and other extractive matters being now thoroughly removed, and the separation of the fibres almost completely effected. The steam generator to which we have alluded is specially constructed for carrying very high pressures, and is, contrary to the opinion of timid or superficial observers, perfectly safe. An examination of every part of it while in process of manufacture has convinced me that every possible source of danger has been carefully guarded against in the most ingenious and trustworthy manner. I consider it due to Mr. Sinclair to say this much, for he has applied himself most laboriously and, as I have already said, successfully, to render such a formidable machine unobjectionable on the score of safety.

Besides the method of treating wood which I have just described, many other processes, both chemical and mechanical, have been proposed. I have myself made a very extensive series of experiments with the view of discovering some cheaper method, but the same practical difficulties have interposed themselves in the way as have rendered abortive the labours of others in the same direction. Several chemical agents completely and easily effect the desired object of removing the intercellular matters leaving the cellulose pure, but they are either too expensive, too dangerous, or too difficult to recover. This latter objection is now a serious one, as the manufacturer can scarcely hope to be allowed to run such powerful chemical agents as I refer to either into sewers or streams. The mechanical operation of grinding or rubbing down raw wood into a powder is carried on extensively in America, and also, though on a smaller scale, in other wood-growing countries; and a portion of the product reaches the British papermaker. This wood powder can scarcely be dignified by the name "fibre," although care is taken to apply the friction along the axis of the wood and so brush off the layers, and thereby give the product as fibrous an appearance as possible. The product of the grinding process contains all the lignine, resin, and other matters natural to the wood used; it has little or no felting power, and can only be viewed as a species of loading.

I am fully alive to the importance of having our paper-stock resources developed and extended, and am ready to admit that even this powder is a contribution in that direction which we cannot afford to despise. We must welcome all additions to our resources, bearing in mind the fact that we are not consumers of strong white papers only, but of papers of all classes and characters, for the manufacture of some of which very wretched stuff indeed is found quite suitable.

Erratum.—In the first lecture, page 60, second column, ninth line from foot of page, for "tube" read *tub*.

MISCELLANEOUS.

HEALTH.*

By Edwin Chadwick, C.B.

(*Continued from page 70.*)

Normas of Sanitation obtained by Improved Civic and Private Constructions.

I now proceed to notice the normas of sanitation evolved by local or private effort for the protection of civic populations.

In about thirty of the smallest towns, sanitary works were attempted by local authorities on lines adopted by our first General Board of Health, for systematic sanitation, namely, by the removal of damp by the drainage of sites with permeable agricultural drains,—by pure supplies of water, if possible from spring sources, delivered direct into houses on the constant system of supply, without cisterns and without waste,—by the constant removal from within the house of all putrescible or fæcal matter by the water-closet, together with all the fouled water from the kitchen or the laundry, from the house, through self-cleansing house drains,—by the constant removal of such matter from beneath the site of the town through self-cleansing sewers,—and by the constant and direct application of all such foul or waste matter as was removable in a liquefied form (perfectly fresh) or free from advanced decomposition, as manure on to the land for agricultural production. There was to be no stagnation anywhere, no time given for advanced decomposition, and no production of putrid-sewer gases to be discharged either into the houses or into the streets, or above them into the general atmosphere. Normas of the self-cleansing sewers, and of the application of the sewage to the land, were separately considered, and separately established at great pains. Trial works were got, as to the forms, sizes, and inclinations of channels, that should be self-cleansing with the least quantity of water. Our objective points of sanitation were, first the house, next the street, then the town area, and, last of all, the river. It was established that, as a rule, pure supplies of water could be brought to the door for rates amounting to a penny per week, and carried into the house for another penny per week; and the waste water of the scullery or the laundry removed for another penny; and the cesspit abolished and the water-closet added for another halfpenny, or in the whole threepence per week, or a halfpenny per diem, for a complete system, in which there should be no putrid-sewer gases, and in which you might test the competency of the sanitary engineer by the smell. We showed that three houses and three towns could be sewered well at the cost heretofore incurred for draining one town ill, on the old plan of brick drains of deposit and large man-sized sewers of deposit, which were only extended cesspools for the generation of putrid-sewer gases.† At these prices works were done then, and, allowing for the advanced price of labour, may be done under competent administration now. To this work for the removal of putrescible matter from within houses and from beneath streets and towns, was added the covering of footways and the roadways of streets with some impermeable surface, and the cleansing of it by a jet of water, from a hose and hydrant, to be used on occasions for the extinction of fires. In blocks of houses and whole towns cesspools have been removed, and water-carriage through the water-closet, with self-cleansing drains and self-cleansing sewers have been substituted. Physicians in practice in such localities have testified on their experience, that, house to house, as the improvements were completed, and the atmosphere of the house was altered, low headaches were removed, the appetites improved, and the symtoms premonitory of advanced disease were abated, and that their practice was largely affected. But it is difficult to get satisfactory statistical estimates of the results, because they have not been appreciated or regarded by the ignorant local authorities, and the returns are not available distinctly for the houses where sufferings have been alleviated; and even in respect to the towns where such works have been effected, the registration includes outlying houses and undrained detached villages, which are unimproved. Nevertheless, in the statistics for the places where the works have been carried out in principle, even in a rudimental manner, reductions of death-rates by one-fourth, and even by one-third are frequently shown. In 1866, an examination of 25 of these towns was made by the Medical Department of the Privy Council, but without a due knowledge, as it appeared to me, of the nature of the works or of what was to be expected from them, or of their defects. It came to my knowledge subsequently that the works of some of them were grossly defective, and wretched houses, rooms, and room tenements had remained unimproved. Nevertheless, the general results obtained were reductions of the general death-rates (after excluding small-pox and infantile epidemics) about 12 per cent., of typhus fever 41 per cent., of phthisis in a number of cases more than 40 per cent., and of diarrhœa a mean of 18 per cent., and a reduction of the general death-rate of more than 9 per cent. The commentary by Mr. Simon on these results, was that "they may serve to fulfil very important provisional uses, not only to confute persons who have despaired or affected to despair of any great preventibility of disease, but still more to justify in the public eye, and to encourage in some of the noblest of human labours, those who for long weary years have been spending their powers in this endeavour, and to whom it will be the best of rewards, to see the demonstration of the good they have wrought." More is to be lamented for the good that has been frustrated, than is to be rejoiced at or the shortcomings obtained, and it will be proper in the interest of the future, to display hereafter the obstructions continued against the complete and extended applications of settled principles of sanitation. But for the present I must confine myself to the showing the progress of the power of sanitation, and the demonstrations of such distinct normas as have been got. For the reasons heretofore stated, I deem the available statistical evidence derivable from the experience of whole, even of improved towns, at present insufficient to display the full power of sanitation. In my experience, however, the statistics may be inferred from the aspects of the places, and from the aspects of the people. After traversing different districts and observing the difference of their conditions as to cleanliness, drainage, and other sanitary points, when I have been enabled to get out the statistics of the death-rates street by street, I have found they have corresponded closely to what might have been anticipated from their relative conditions. Nay, from the contrasts of the classes of destitute orphan children in the district half-time schools, I could anticipate, where there were marked contrasts in their conditions, very much of the different death-rates of the places whence they came. And here I would mention an experience

* Opening Address to the Health Section of the Social Science Congress.

† Some of the principles were first developed under the Metropolitan Sanitary Commission, 1848, and in trial works carried out in that and the next year under the Metropolitan Sanitary Commission. As to the principles of water supply they were expounded, in the Report on the Supply of Water to the Metropolis in 1850; next, in the "Minutes of information on the drainage of land forming the sites of towns, in the drainage of suburban land, and on road drainage," issued by the General Board of Health in 1852; also "Minutes of information on the removal of soil water and the drainage of dwelling houses," and "Minutes of information on the practical application of sewer water to agricultural production," issued by that Board during the same year.

from my own observation. I have been in the habit of visiting those institutions at long intervals of time. At a late visit to one of them, I was struck with the improvement of the type of the children. I observed to the manager, "Why, you have a different class of children to those I last saw here. Where do they come from?" The answer was, "They come from the same districts, the lower districts, but since sanitary improvements have been made in those districts, we are getting a different type of children, as you see." I found that the medical officers, as well as managers of other institutions, confirmed these observations by similar experiences. Others than myself have made the observation that since the clearances of bad dwellings, and the wider spreading of the habitations of the wage classes in Paris, that they are changing that leathery complexion—so much like the inner soles of old shoes—which they formerly had, for one clearer and fresher. Such changes are in accordance with our anticipations, and it is satisfactory to observe distinct appearances of their realisation for future promise of large improvements in the types of populations.

I should anticipate with confidence, from such appearances, a reduction of the death-rates to be marked by statistics if they were got out. The blocks of model dwellings in London, erected by voluntary associations, present better observed and clearer instances, serving to some extent as normas of the preventive power of sanitation. In these the death-rates range separately from 14 to 17 per 1,000. I assume that in the metropolis 16 per 1,000 may be taken as the mean death-rate of similar improved habitations; that, I need not say, is an important advance upon the general death-rate of 23 in 1,000. But a death-rate, which is a mean of the deaths of a large city, is almost always a delusive misrepresentation, especially of the extremes. Thus we have part of a sub-district in London, comprising houses in good condition, where the death-rate does not exceed 10 in 1,000, whilst there are adjacent dwellings chiefly occupied by the wage classes, where the death-rates from year to year keep up to the extent of 38 per 1,000. Important returns, with which I am favoured by Dr. Russell, the medical officer of Glasgow, show, for the last year, a range of death-rates, from one district at 15 in 1,000, to another district at 40 in 1,000. Now, a mean of these two, or the general routine mean (25 in 1,000, with sub-districts of 17 in 1,000, 24, 26, and 33 in 1,060) is a misrepresentation of each. It has lately been proved that in some of the dwellings condemned under Mr. Cross's Act, the death-rates were as high as 50 and 60 in 1,000. It has been objected to the conclusions from the lower death-rates in the model dwellings, that the people living there are generally of a better class in position and habits. The answer is, that if the same people were taken into the inferior tenements their habits would deteriorate, whatsoever may be the increased amount of wages they obtain. But the power of sanitation is displayed upon people of the lowest condition and habits in the metropolis—namely, the tramps who occupy the common lodging-houses, regulated under Lord Shaftesbury's Act. These places were formerly distinguished for the first outbreaks of typhus and epidemic disease. Drainage, water supply, and the means of cleanliness and ventilation are now enforced, and overcrowding is prevented in them, and they are now distinguished by an immunity from common epidemics. Medical officers of the districts where these lodging-houses are situated have testified to the better sanitary condition of their occupants than of the wage classes dwelling under the jurisdiction of the common vestries. Dr. Russell states to me that "in the large model lodging-houses of the corporation a case of fever is of the greatest rarity, and it never spreads. In the common lodging-houses belonging to private individuals we have fever oftener, but there again it never spreads"—that is to say, as it does in defective houses of the wage classes. "We are informed of a case at once, and remove it immediately to the hospital. Fever of any kind never spreads in any of our institutions, where I can do as I please to cut it short." Why should not similar protection be extended to the wage classes? Accepting my norma of sanitation in the prison, Dr. Russell says:—"If I had perfect command over all the Irish in Glasgow, as the governor of a prison, I would reduce the death-rate one-half in five years, and in less time than that, I expect." On the whole, death-rates in the model dwellings may be fairly placed in opposition to the common death-rates prevalent among the wage classes of the metropolis, where it is upwards of 30 in 1,000; or, as an example, of a gain of one-half upon that special death-rate by the power of sanitation. His Majesty the King of the Belgians has offered an international prize which is calculated to be of high service, as conducing to a better determination of the power of sanitation, and its vindication before Europe. He offers "a gold cup of the value of 5,000fr. to that municipal or local authority, or private association, which shall, by an improvement of the dwellings of the wage classes, effect the greatest reduction of their death-rates at the lowest cost." I have been informed of instances of model dwellings on the Continent where a lower death-rate is supposed to have been attained than of those in London. But an instance is stated by Dr. Tatham, the medical officer for Salford, which, if correct, would gain the cup for England. It is of a block of model cottages—a model village—erected for the workpeople of Messrs. Price and Co., near Liverpool, where the average death-rate for the last five years has been eight in 1,000.

On a review of the facts I have adduced, I think I have proved that by sanitary measures, under such regulations, it is quite possible considerably to reduce the common death-rates. I state that we can so arrange common conditions to multiply the most fatal orders of disease, and that we can command conditions as to induce them as effectually as to prevent them. If I might resort to the Hindoo mythology, as formulating or embodying maleficent and beneficent principles, I may say that if Siva, the Destroyer, were to require it, we could certainly build a city in which we could ensure a death-rate of 40 per 1,000, or far more than double the general mortality of the country. For that purpose we should copy literally and closely the old parts of Whitehaven, those of Newcastle-upon-Tyne, and the wynds of Glasgow and of Edinburgh, which I have heretofore traversed, and some edifices in Paris and Berlin, and some tenement houses and crowded slums reported of in New York and Boston. We can reproduce conditions of damp and of filth, and of darkness and of confined, stagnant air, and induce the specific diseases found in those conditions. I have asked relieving officers in London whether they could take a dozen cabs and fill them with fever cases, of which particular cases they had received no notice. Yes, they replied, they could readily find enough, though they might not be quite sure of tho sort; the cases might be of typhus, they might be scarlet fever, they might be measles, they might be small-pox. But some cases of the eruptive diseases they were sure to find. Let those places be looked to and copied. There were instances, even of particular houses, which the medical officers were sure would be the first to be attacked on any renewed epidemic visitation. There was one house, or street, in York, which we were informed by tradition was the first attacked by the great sweating sickness; then the first by the great plague; and, lastly, the place which cholera selected on its first visitation to this country. On the second visitation, during my service, we had an outlook whether the place would be true to its traditions, and it was so! Let that be copied. As a short cut to get at the places for sanitation, I have instructed sanitary inspectors to go into the primary schools, to put aside the most squalid and inferior children, ascertain their residences, and examine them. They have done

so, and, as a class, they have found the most wretched tenements to be the fever nests of the city. I remember that Dr. Lyon Playfair, then a pupil in sanitation, told me that he had, with other visitors, acted on this suggestion, and noted amongst the class of squalid children two whose faces were blotched from disease. They found that their habitation was over the confluence of a discharge of putrid sewage. Let such places, too, be included. By copying these places, and repeating these conditions with fidelity, we may ensure with certainty that more than half those born shall be in their graves by the fifth year, and that those who survive shall be stunted, squalid, irritable, and weakly. We may, by such insanitary conditions, reduce the proportion of the aged and of the middle-aged, and of persons of mature experience, and increase the proportion of the young and of persons of immature experience, to the rest of the community. We may reduce the steadying influence of experience, and augment the preponderance of passion and of blind impulse. We may, by the excessive sickness and death-rates, produce a sense of the shortness of life, of its pains, and its worthlessness, and generate a reckless avidity for immediate gratification, such as that which characterises inferior soldiers in time of war. We may, indeed, compound a "hell broth" of "powerful trouble" to the police, as well as to the administrators of relief to human misery. We may produce such results, for they are produced from such conditions, and are displayed in outbursts that alarm and endanger the negligent administration under which they have arisen.

On the other hand, if the beneficent principle, worshipped as Vishnu, the Preserver, should command, we can undertake to erect a city which shall in time be the reverse of all this, and in which the death-rate shall not exceed 10 in 1,000, or one-half of the general average of sickness and mortality, a city which shall be as fever-proof as we have made our orphan half-time asylums and our prisons, without, indeed, materially altering the popular habits, except as to overcrowding; with houses freed from the cesspool smell, from the bad drain and the sewer-gases, from the damp wall, and from the foul wall smell, and from wall vermin, from stagnated and vitiated air, and from the too prevalent exclusion from sunlight —houses that should, by their construction, be cool in summer, and warm in winter, with good water supplies undeteriorated by bad modes of delivery.* I say with confidence, that we might ensure an advance upon the hitherto normal death-rate of 15 or 16 in 1,000 of the present model dwellings; because those dwellings are in my view not yet up to the principles of construction, as the Prince Consort's model dwellings were, in some important points.

Moreover, that reduced death-rate of 16 in 1,000, as against 40 or more, good though it is, must be considerably affected by the condition of the general urban atmosphere in which they are situate, as well as by particular insanitary conditions. As to the general urban atmosphere, surgeons will be well aware that if an accident requiring a serious operation were to occur to the occupier of any of those urban dwellings, his chances of recovery would be considerably improved by removal into a purer suburban atmosphere. With respect to the conditions of urban and country hospitals, a celebrated physician remarked:—"In the city hospital-ward the most expert surgeon cannot cure; whilst in the country hospital-ward the greatest bungler cannot kill." Of the particular insanitary conditions to which the occupiers of these urban model sanitary dwellings are mostly exposed, are air tainted with sewage gas from bad general drainage, and, indeed, much sewer-tainted water by the dung-dust of ill-cleansed streets, befouling skins and clothes,—the children being compelled to go to long-time schools, and to be massed together with filthy-skinned children, the centres of children's epidemics, and by the adults being compelled to labour in ill-conditioned workshops not under the Factories Regulation Act. By the elimination of these insanitary conditions, a reduction of the death-rates of the model dwellings by full one-third may be confidently assured. It might indeed be anticipated that some approach might be made as to children to the condition of the half-time schools, or as to the adults to the sanitary conditions of those great normas of sanitation, our prisons;—that is to say, a condition in which two years out of every three there should be, as it were a sanitary jubilee, in which there should be no disease and no death; a condition under which all men shall attain the promised term of threescore years and ten.

It is not, however, necessary to wait for the construction of Hygeias, to make advances in urban sanitation. What has already been done in old cities, such as Salisbury, where the death-rate has been reduced from some 28 in 1,000 to 17 and 18 per 1,000, what has been done with the common lodging-houses, what has been done with blocks of buildings in the metropolis and in Glasgow, warrants the conclusion that specialists, as sanitary engineers, might now contract for the attainment of important sanitary results. I am confident that data might be given for the reduction of the death-rate of the metropolis, from 22 to at the most 17 in 1,000, and for the reduction of the death-rates of provincial cities in the manufacturing districts in yet greater proportion. I am confirmed, in this anticipation, by the facts obtained from recent returns from Glasgow, where efficient sanitation has lately been applied, and where in one well-to-do district, an urban death-rate of 23 in 1,000, or about the mean of the metropolis in 1871, has been reduced to 17 in 1,000 in 1876. In another district the death-rate has been reduced from 29 to 26, in a third from 35 to 26; and in the worst district from 44 to 33; the mean reduction in that city being from 33 to 25 within that period. I am, nevertheless, of opinion, that by vigorous and complete sanitation, a further reduction of 9 deaths to 17 per 1,000 is practicable in that city. Aberdeen, with a death-rate of 20 in 1,000, is in the fore of Scotch cities; but I believe the death-rate to be reducable there, by complete sanitation, to 14 in a 1,000.

Excessive sickness involves premature working disability as premature mortality and excessive pain and misery involve definite pecuniary loss which the political economist may estimate. On definite data, I have heretofore estimated the money loss from insanitary conditions at about £15,000,000 sterling per annum. It must, however, be much more than that. Happily, this sum capitalised would, under economic rule, amply surfice, in most cities, to defray the expenses of proper works by which the existing insanitary conditions might be removed and a pecuniary gain in productive power effected.

Normal Examples of Agricultural Production obtainable from Town Sewage or Liquefied Manure Culture.

It will serve to show the states of intelligences that have to be dealt with, if I now state to you the normas obtained for the application of the excretory matter of towns to agricultural production, and the sanitary relations of those normas.

With long labour the experience of all Europe was sedulously collected on this subject, and not only agriculturists, but horticulturists, such as Sir Joseph Paxton, skilled in plant-feeding, were consulted upon it. The axiom was adopted of the foremost vegetable physiologist of the last century, Decandolle, "that the future of agriculture would be in giving food and water at the same time." Trial works were obtained on this principle. I got the late Emperor of the French to direct trial works to be made with the sewage of Paris, and those as made by specialists (Professor Moll, of the Conservatoire des Arts et Métiers, and Mons. Mille) were in my opinion the best that have been made

* *Vide* for particular exemplification my Report "on the dwellings characterised by cheapness, combined with conditions necessary for health and comfort," as displayed at the International Exhibition of 1867, at Paris, presented to Parliament, 1868, vol. 2.

hitherto. We got out, at our Board of Health, a manual expository of all the experiences collected, which we issued for the instruction and guidance of local authorities. I have recently visited, with a sanitary officer of the King of the Belgians, some of our towns, where the principle has been moderately well applied, and I may state the normal results verified there and elsewhere. You may be aware that the highest agricultural results, in weight of produce obtained over a given area is, by garden, market garden culture, with the most active tillage and the heaviest doses of manure—almost invariably with solid manure. The common yield from that culture is more than threefold the yield of ordinary good agricultural tillage. But the sewage or the liquefied manure culture for various reasons stated in the manual to which I refer, everywhere exceeds the best solid manure culture, in quality, as well as in weight of produce. The normal results obtained, stand thus:—Where the common agricultural yield is as one, the market garden culture is as three and a half, and the liquefied manure or sewage culture is as five. Where the best of the ordinary pasture land carries one cow, the liquefied manure farms carry five, and the milk yielded is of superior quality. To give an extreme case. The sewage farm of Aldershot is on a close quartz sand, ten acres of which would not have kept one animal alive;—but under Mr. James Blackburn it now keeps four cows in milk and one growing animal. Mr. W. Hope, V.C., states to me that the ordinary allowance of land in Gloucestershire and Cheshire is from 2 to 3 acres to keep each cow the whole year, and he says "one year I kept in capital condition, between 60 and 70 head of horned cattle and 14 horses for three months upon 7 acres of sewaged Italian rye-grass. He estimates that each human being represents not less than 1,000 lbs. of possible rye-grass per annum, and that "each human being represents 85 quarts of milk." He states in answer to my question, as to the waste of manure going on at present in London (and more or less in all our large towns),—"that taking the population of London at 4,000,000, they (the representatives of the vestries) are at present injuring the oyster and other fisheries at an expenditure of 340,000,000 quarts of milk yearly. But I give you this calculation purposely as greatly within the truth. Yet taking only one penny per quart of milk as due to the grass, *i.e.* to the sewage, and allowing as much more for the land, the farmer, and the cow, we have an annual preventible waste of manure that can be realised amounting to no less than £1,411,111, and again I say this credit of our penny is too little, I believe it will be found that this estimate is substantially correct." But there arises some important sanitary conditions, in connection with the external agricultural economies of the question. Between sewage manure that is fresh or undecomposed, and sewage that is putrid from having been retained in a state of decomposition, in cesspools, or in drains of deposit, for weeks, or months, or years, until it is flushed out artificially or by storm,—there is generally a difference of at least one-third. Putrid decomposition of sewage in ordinary weather in England I have ascertained begins in about four days; and discharged into rivers in that condition it kills fish; but when discharged from towns that have been water-closeted, through self-cleansing drains and sewers, that is to say, immediately before decomposition begins, it feeds fish, and increases their number and improves their qualities. The finest fish have been caught at the mouths of sewers of towns drained with self-cleansing channels, and where from administrative incapacity they have not tried or have not succeeded in getting the sewage applied to the land. A case for litigation as stated to me illustrates the position of the sewage farmer in relation to the sanitary condition and the administration of the town. A farmer contracted with a town, which had been newly water-closeted and drained, for the whole of its excretory matter. On that contract he invested his capital in laying out a farm with appropriate farm buildings. But when he came to the application, he found that the whole of the town had not been sewered as represented, and that much of it was badly drained, and that, as a consequence, he had a less quantity of manure than he had contracted for, and that manure of an inferior quality. He has brought an action to recover damages, and, assuming the case to be as stated, he is justly entitled to them. The case is important, as showing the interests of agriculture in complete sanitation. But it is to be observed that the inhabitants, at the same time, have their injuries from the sewer-gases generated and distributed into their houses from unskilful drainage. I recently visited Croydon with a sanitary officer sent by the King of Belgium, and asked: "Were the 16,000 houses there all water-closeted?" "Yes, they were." "Were all the sewers self-cleansing and free from smells?" "Not all; some were sewers of deposit." "How so?" "They had in one quarter of the town been badly jointed by the contractor. The sewage leaked out at the joints and permeated the site, and the flow being diminished, deposit was occasioned, and putrefaction and sewer-gases generated, and outcries raised for sewer ventilation." Dr. Alfred Carpenter (a distinguished physician and member of the local sanitary authority there) and the engineer stated that, as a rule, the fever cases in the town occur in the district of the defective works, where the common putrescent sewage of deposit generates sewer-gases and foul smells; this interior injury to the health of the population having its exterior injury to the sewage farm in the reduction of the quality, the quantity, and the value of the produce. On visiting the sewer farm of the Camp of Aldershot, I went at once to the outfall, and said, "Why, this camp is badly drained!" "Had I seen the plan of the drainage works?" "No; but," I said, "I smelt that it was badly drained, for the smell at the outfall was the smell of putrefaction—the old sewer smell of the sewers under the jurisdiction of the London vestries." And it was so. It was the farmer's grievance that the sewers had been made large enough to receive extraordinary storm waters. As a consequence, the ordinary sewage, instead of being concentrated for a quick discharge—which, with properly-arranged works, carries any gas with it from the friction of the water on the air in the pipe—has a retarded flow, which occasions deposit, and hence decomposition, and waste and deterioration of the manure. Moreover, the deteriorated manure was at times brought down on that farm in such flushes, and so excessively diluted, as greatly to encumber the farmer's operations. I have found that, from the defective engineering, this is a prevalent defect complained of by sewage farmers, that will necessitate laying down separate and smaller sewers in conformity with the first principles enunciated. I may mention, *en passant*, another peculiar grievance of the farmer of the sewage of the Camp at Aldershot, as it elicited a strong illustration of the value of the manure. When he took the farm and executed his works for the reception of the sewage the camp was a stationary camp of some 8,000 men. But since then the autumn manœuvres occurred, taking away the manure of his farm just at the time he most wanted it, and he bewails the departure in each man of his equivalent of the 85 quarts of milk, and of the "awful" expense to which he is put for artificial manures to avert the consequences of their absence. Added to the cause of irregularity and inferiority in the quality of the sewage from the admission of water which is not due to the field, but to the river, there is another and large cause of deterioration in towns by excessive dilution from the waste water from the house service-pipes. The common practice has been for the engineer to carry the water in the mains only to the doors of houses, and to leave the house services to be put in by common plumbers, without system and without supervision, and, as a consequence, with every variety of defect. We ascertained by gaug-

ings that the waste of water in the metropolis was full three-fifths of the water pumped in. In part this waste supersaturates the soil, and, through defective drains and sewers makes it sodden with excrementitious matter; and in part it adds to the deterioration of the manure by excessive dilution. From these causes many a cry is raised that "sewage is worthless as a manure, as it is declared to be not worth more than a halfpenny a ton."

Putridity of sewer manure, the spoiled manure, assumed to be a constant, is used as a pretext for the refusal of land for it in the vicinity of towns, and for the exaction of excessive rents for land anywhere for its use, as being injurious to the land, as well as offensive to neighbourhoods. Plain water irrigation, by the method of stagnant submersion is, however, productive of fever and ague. Fresh sewage manure if mismanaged so as to supersaturate the land and produce surface decomposition by stagnation, may be made highly injurious. But high culture, market garden culture, with heavy top-dressings of solid manure, almost of necessity kept during long periods in states of decomposition before it can be absorbed by the soil, sanitarians know very well are injurious and unfit for the close vicinity of habitations. The way to prevent injury to the public health from such dressings with solid manure, and at the same time to augment its productive power, is to liquefy it, and apply it in the liquefied form in quantities adapted to the receptivity of the soil and of the vegetation, as horticulturists and the growers of prize fruits are skilled in doing. Examples were adduced, where, by this process, more than a double fertilising power was imparted to a given quantity of solid manure. The common waste of the farmyard manures and of solid manures generally in common agriculture throughout the land, was estimated by the late Mr. Smith, of Deanston, a distinguished agriculturist, as equivalent to an additional rental. At a time when town sewage was only known in its then condition of putridity—the condition in which even medical officers in old urban districts only know of it now—I got trials made on a small scale of a method of subterranean distribution through permeable agricultural drain-pipes. I got Sir Joseph Paxton to make trials of this method, and they were very successful. They, however, required great skill, and were comparatively very expensive. But the discovery that the condition of putridity was not a necessity, and demonstration of the comparative freshness of the condition of the sewage from self-cleansing house drains and sewers, and of the inoffensiveness and the convenience and greater cheapness of surface-distribution, led me to desist from the prosecution of the method of subterranean distribution. Nevertheless, this method has been independently prosecuted with much success by the late Mons. Charpentier, a vine grower of Bordeaux, and I consider that it will be found to be eligible under certain conditions, especially for the culture of fruit trees and of ornamental timber near cities.*

It will naturally be asked how, with such a cheaper method of removal and conservation of the manure than all others—that by water-carriage—and with such cheap and convenient methods of application to the soil, and with such rich yields, exceeding the highest of common market garden production, sewage farms seldom pay, and are generally attended with loss to the towns? In part this is explained by the mismanagement I have stated. Moreover, sewage farming does not pay when the Legislature sanctions, as it has done, exactions of five-fold value for land; sewage farming does not pay when a town is put to as much expense for obtaining a local Act as would suffice for the construction of a first-class farm-steading; or when a town has been subjected to a Parliamentary conflict, and to such expenses as £10,000, to which Birmingham has, I understand, been subjected —a sum sufficient to have defrayed the expenses of preparing more than 1,000 acres of ordinary land—it does not pay when the engineering expenses belonging to the internal works of a town, such as the pumping works for carrying away the sewage, which would have to be paid if it were thrown into the river, are charged to the farm—it does not pay for works of the ordinary scale of works of engineers who are not agriculturists, and not conversant with the necessities of agricultural economy —it does not pay when, to use the expression of Lieut.-Col. Jones, of the Wrexham Sewage Farm, in reference to so many examples "scattered over the country of sewage farms with massive vaults for tanks, and permanent carriers in places where they only encumber the ground and stop the plough, as well as of bad subsoil laid bare in ruthless levelling—when farming considerations are less regarded than the execution of those great engineering works laid out on the understanding that something solid was required by the ratepayers for their money, and that their engineers should be paid by a per-centage on the cost of the works to be executed." Neither do sewage farms pay when they are subjected to the scales of expenses of municipal offices for unskilled service, or for inferior service that is not special, as "that of a common farm bailiff, at 25s. a week, to please some fifteen or twenty masters, town councillors, who have no experience in agricultural pursuits, but who must all have a vote, on entirely new and difficult farm management." But they do and will pay, as stated by Mr. Robert Rawlinson and by Mr. Clare Sewell Read, himself a successful farmer, in the conclusion of their report on an examination of all the present methods of disposing of town sewage: "Where a fair rent is charged for suitable land, the sewage is regularly delivered, and a good market is close at hand, there is no reason to doubt that the return for capital judiciously expended upon sewage farms will produce a higher rate of interest than the money invested by the majority of tillage farmers throughout the country." It was not within their province, or those two able and practical men might easily have shown the conditions in which, after so much had been done to make the sewage of little worth, localities had been led by railway or other insanitary engineers, who know nothing of agriculture, to give no trouble about it, and to allow the construction of great tunnel sewers, to throw their manurial matter into the sea, at manifold the expense that would have sufficed to effect superior applications of it for the production of food and the advancement of agriculture.

Market-garden farmers admit that sewage farms have great advantage over their culture, in being supported by the constant regulated supply of water to the city, and in being protected from droughts and the irregularities of rainfalls. It may be added that the sewer manure farms have a peculiar advantage over the market garden farms as well as ordinary farms, in the ready and superior means of feeding the plants by liquefied as compared with the common feeding by the solid manures. I have known a liquid manure farmer who regulated his plant-feeding as he wanted woody fibre, the leaf, or the fruit developed, and who at will could change the colour of the leaves in twenty-four hours. This could not be accomplished with solid manures. By the liquefied manure culture the character of the produce is largely changed: there is a larger production of farinaceous and saccharine matter. The liquefied manure culture converts some plants almost into new ones. The sewaged rhubarbs have been sought for their excellence to make champagne or a superior still hock. The finest perfumes known are yielded for the boudoir of fashion from what would be the odious stench of the wynds or alleys. It may be hoped that this liquefied

* Mr. Rogers Field, C.E., has carried out some very successful examples of the subsoil sewage irrigation of gardens attached to villages and mansions and to a public school. For this purpose he has contrived a flushing tank which, by a syphon arrangement that is self-acting, discharges the contents once or twice daily, through permeable pipes underneath the garden, amidst the vegetation. It works perfectly, and may lead to important extended applications of the principle.

manure culture will develop and accustom the people to new and superior edibles as common food, to give relief from the terrible consequences of main dependence on single crops—an evil against which the increasing insect visitations are giving additional national warnings. This liquefied manure culture, with the excreta of cities, when perfected, will, I consider, be an advance of what I have heretofore contended for, as a principle of agricultural economy, the economy of what I have called "intensive" culture and food manufacture in narrow areas, as against extensive or thin culture over wide areas. For if we obtain, as has been shown by the established normas, a fivefold yield on the same area, there will be required only one-fifth of the extent of drainage for the removal of surplus moisture, one-fifth of roading, one-fifth of the space for the removal of crops, and one-fifth of the hedging or the outer fencing of farms. On the principle of intensive culture a higher order of works and of machinery may be afforded for food manufactures. In this view well-cultivated sewer farms may be made subjects of superior national agricultural instruction.

A metropolis, as the centre of science of an empire, with endowments from common funds for common benefit, may be expected to take the lead in the practical applications of science for the advantage in guidance of provincial cities. This becoming position Paris has maintained in what is called the "sewage difficulty." It has referred the subject to superior scientists and practitioners, who have expounded it in able and guiding reports for the information and guidance of the provincial cities of the Empire. The French Commission has set aside at once the preposterous notion, got from the representatives of the vestries of London, of carrying the sewage of the metropolis to the sea. It rejects the principle of collection and removal of the excreta by the pail, of which Paris has had too long experience, and will proceed to substitute water carriage as soon as it is deemed practicable. It rejects all plans of intermediate precipitation, of solidification, of chemical treatment, of disinfection, and of the manufacture of patent manures, such as are in conflict in England, having had long experience of the inconveniences and the little advantage of the declining manufacture of *poudrette* in Paris. Having examined these projects in principle and in detail, it concludes by the affirmation of our principle of the uninterrupted and constant conveyance of all excretory matter possible by water-carriage direct to the land, and it has set the practical example of it, close to Paris, where, but for the interruptions of the war of 1870, it would now have been largely and systematically developed on a scale of agricultural grandeur. At present the applications have been chiefly by small farmers, and consequently in rude methods. But I trust that, by the next year, the sewage farming of Paris will have its place as an important adjunct to the International Exhibition. Dr. Folsom, secretary of the State Board of Health of Massachusetts, has visited the chief sanitary works in Europe, and has presented a report upon his examinations, very much in accordance with the conclusions of the French Commission as to the superiority of the direct sewage applications.

There is one practice in cities passed by as a detail of no great importance in sanitation to which I beg to call attention. We found in London that at least 1,000 loads of horse-dung were daily deposited from the traffic on the streets. The interest of agriculture is that this mass of valuable fertilising matter—some 350,000 loads a year—should be carefully preserved. But it is spread about, triturated, and a large proportion of its finest constituents lost by the evaporation which makes the streets at times smell like ill-kept stable-yards. So much of the street-mud, of which it is the chief constituent, as can be gathered up by hand-labour is removed at intervals, by the expensive method of cartage, so that the waste is very considerable. But the sanitary interest of the population is that the removal of it, as a source of the pollution of the air they breathe, should be accomplished as quickly as possible, and that they should be obliged to breathe pulverised horse-dung, as they are, which forms by analysis the greater proportion of the mud and dust of the streets that so defouls the skin and the clothes as to require continual extra washing and labour to maintain cleanliness. The injurious effects of London street mud may be inferred from the experience of Mr. H. Graves, the print publisher, who states that an engraving may be cleaned from ink or from oil, but not from London mud. Now, the most effectual mode of street cleansing is by water power—by the jet from the hose and hydrant. We had complete trial works of this mode of cleansing, and found that whilst it was more rapid and effectual than cleansing by the broom, it was not half so expensive. It partakes in principle of the removal by the water-closet, and of the direct conveyance to the manurial matter to the land in the quickest manner, and placing it in immediate chemical combination with the soil, with the least loss. We also recommend the system for the collateral purpose of fire prevention, by having an apparatus available for the purpose always ready. Paris has adopted the method propounded, as did Hamburgh long before, with a large reduction of its fires; and as to that matter, I beg to mention, by the way, so has Manchester, Liverpool, and Glasgow, as to fire prevention, with a reduction of their previous losses by fire by two-thirds. By this method of cleansing an appropriate impermeable pavement Paris has acquired the name of "clean-streeted Paris." And it is noted by French sanitary authorities that marked improvements in the health of the inhabitants have followed the extension of the improved impermeable paving and of this mode of surface-cleansing.

Mons. Mille, the engineer-in-chief of Paris, has made a report on the works of sanitation for the metropolis of the German Empire, Berlin, and he points out that they are on principle derived from the report inspired by myself. We might claim as due the acknowledgment of some principles and details of our original elaboration, that have been adopted in Paris, beyond those I have stated, as the abandonment of river supplies for spring supplies, a measure in which Paris is in advance of London.

Our plan for the sanitation of London was first to put the whole of the water supplies under unity of management on a public footing. Successive Royal Commissions have reinforced that conclusion. We next proposed to abandon river sources of supplies, as of unavoidably inferior quality, if not from the sewage of towns which might be diverted, from the surface washing of lands which could not be diverted, and we prepared to resort to spring supplies, of which we found in the Surrey sands springs of soft water of double the then actual consumption of the metropolis. Whether they would now suffice for the increased population, and what assistance would be needed and available from other sources, would be matter of inquiry. But the delivery of these spring sources would have been constant and direct to the house, without the intervention of any external subsidence or filtration reservoirs, or any stagnation in internal cisterns, which would be unneeded and detrimental. The fouled water, with all excretory matter, would have been in course of constant removal through self-cleansing impermeable drains from beneath the sites of houses, and through self-cleansing sewers from beneath the streets and the site of the metropolis. By steam power mostly, such as that by which the fresh water was carried into the houses, the fouled water would have been carried from them, and be distributed in several directions on to land fitted for its reception. We prepared for the agricultural treatment of the sewage of the metropolis in at least four sections, pumping backwards to the S.W. as well as to the N.W. By the concentration in pumps for sectional distribution, we should have increased falls and the rapidity of the dis-

charge, and we were perfectly confident that, as a general result, there would be no stagnant fæcal matter in the metropolis, and that the whole of the fouled water would be deposited as manurial water—not in suspension but in chemical combination—in the soil within the day. Of the interruption of our preparations and expositions by an epidemic visitation of cholera, with which we were charged to attend, and of the working in Parliament of the opposing sinister interests, it may be useful for public instruction to give an account hereafter.* But it is for the immediate purpose of the advancement of sanitary science to state that the German engineers have (as stated by M. Mille), upon a study of our principles, adopted them, and are closely applying them for the sanitation of Berlin. The river Spree is perhaps one of the least objectionable of river sources, but collections of waters are now being made from beneath the sands near Berlin in close analogy with the proposed spring collection of water near London. These sands near Berlin, uncultivated and almost barren, constitute superior natural filters even of the rainfall, and the water so collected is delivered direct, on the constant system, to every house in that metropolis. A new and self-cleansing system of sewers is in formation, and house drains are in course of construction and connection with them, for the constant removal of all excreta as sewage, and for its direct application to the land. The German metropolis is for this purpose treated in five sections, with a main pumping station for each; and the sewage will be pumped out by two lines of mains to two large farms on sandy land like that of Aldershot, one farm north and one south, for which altogether about 4,000 acres of land have been provided. The house connections are not yet completed with closets, but one farm of about 400 acres is already in operation, and one crop has been taken from it, demonstrating the extraordinary development of productive power by liquefied manure.

On the whole, I submit, from such evidences derived from increasing practice, that the venous and arterial system of sanitation for the protection of urban populations is safe for eventual general adoption with the progress of science, in respect to economy as well as for health.

On the occasion of a visit to Berlin, the Governor did me the honour to ask my opinion of the plan of its sanitation, and I could not do otherwise than express my gratification at the affirmation they gave of our principles, and my confidence that if they were applied with completeness in the details, Berlin, from being the lowest in sanitary position, would be raised to the highest of any capital in Europe, and be made the worthy seat of the great German empire.

The old city of Dantzig has been made a sort of trial work of the principle of venous and arterial circulation, Water-carriage has been introduced there for a large proportion of the houses, and a direct application of the sewage to the land made by M. Von Weibe, the engineer, and Mr Aurre, the contractor, with complete success. A material reduction of an excessively heavy death-rate has followed the introduction of the system of water-carriage from the houses, and crops such as have never been obtained before from any culture have been raised from the adjacent lands. At Hamburgh, where I was credited by Mr. W. Lindley, the engineer, with the principles of sanitation applied to the houses, and at Dantzig as well as at Berlin, the practicability of the system of water-carriage during long severe frosts has been established. At Dantzig, and subsequently at Berlin, the practicability of the regular distribution of the sewage to the land underneath the ice and snow, has also been demonstrated, and the necessity of large storage reservoirs of sewage during the winter obviated. From His Excellency the Governor of Dantzig, Von Winter. I have received a very gratifying account of the public appreciation of the work of sanitation, marked by the increased application for houses where the works have been completed.

As far as my observation goes, in England, as a rule, the sewage of about 100 persons may be utilised on an acre of ordinary land. Local conditions differ materially, and at Berlin, Mr. Holbrecht anticipates that he may be able to utilise the sewage of about half more of the population on that area. But he is of opinion that for efficiency and profit a smaller number will probably be found to be better.

The Powers of Sanitation available for Colonial and Indian Cities.

The principles so tried, examined, and sanctioned, will be found by competent authorities to be peculiarly adapted for the sanitation of colonial, and especially for Indian, cities. A lady traveller stated, that in travelling through India, she knew at night that they had come to an Indian city from being awakened by the stink. This fact would denote to the sanitary scientist that she was awakened by the waste of manure—the horrible waste by evaporation of the finest elements of vegetable production for the sustentation of a famine and fever-scourged population. You may now test a condition of civilisation of a legislature, and of an administration, central as well as local, by the smell. On such experience as I have cited, the waste of manure in famine-stricken Madras would suffice to sustain some 20,000 head of cattle, and the equivalent of food for the population; and double that in Bombay. A friend, an engineer officer, Capt. Baird Smith, when he was at home on leave, asked my advice, for the occupation of his time in professional study for use in India. I advised that he could not do better than study the irrigation works of Northern Italy. He did so, and published a book about it for his brother engineer officers in 1852. Sir Arthur Cotton had demonstrated, to an extent of which I was unaware, the policy and profit of irrigation works. If that policy had been pursued, and if we had given the people water (even plain water), we should not now have to be giving them bread. Of late, however, instead of carefully collecting and carrying to the East the latest improvements in science, and especially this new science, as I may call it, the new power of giving to plants food and water, and also at the same time relieving cities of the causes of depression, sanitary engineers have been carrying to the East the oldest and most expensive errors of the West. As an example. A local plan for the drainage of Cawnpore was referred to me for my observations, from the Works Department of the Indian Government. I found it to be a plan mainly for the construction of sewers of enormous size to receive and carry away extraordinary quantities of storm water, which might well have gone direct to the river, whilst the expense would have sufficed for the proper drainage of the houses. On this scheme I wrote a paper expository of our tried and proved principles of water carriage as applicable to Indian cities. The Duke of Argyll approved of this exposition, and directed the attention of the Governor-General and of the local officers of works to it. The objection those officers raised to it was incompatible with the habits of the natives. This is the same objection that was at first raised to the system of water carriage here. Local authorities, vestrymen, generally small landlords, who from an ignorant dislike of the expense of altering their tenements, insisted that a water-closet was utterly unsuited to the habits of the people; and that the tub-system of removal, which required no immediate outlay to them (the landlords), and the working expenses of which were to be paid out of the rate, was the proper practical system. We set aside these ignorant and selfish pretexts, and water-closets have now been brought into systematic use for masses of the population, comprising

* The mortality in the metropolis, which should have been largely diminished, has during the two last decades increased. In the decade from 1851 to 1860 it was 23·6 of the population. In the decade from 1861 to 1870 it was 24·3.

classes as low as the lowest of any of the most barbarous classes in Indian cities, and in a very little time it is found to be satisfactory in its working, and the objections as baseless here, as under good rule they will be proved to be in the Indian cities. The expense of the bad imperfect system of removal in the tub system in Bombay, even by the cheapest Indian labour, apears to be double the expense of water carriage in England. I grant that a daily removal of the tub system is better than removal to sewers of deposit. If, however, it passes the skill of the insanitary engineers to construct no other than extended cesspools, let them, for the safety of life, give place to competent specialists. But the first advance in sanitation by water carriage may be in relation to the economy and application of the manure of the Indian cities, where the waste, by burning and throwing it into streams is enormous and most reprehensible. Even the solid animal matters may be made to feed edible plants, instead of dogs and vultures. The introduction of liquefied manure farms, to receive and apply at once the excreta of cities, would have the peculiar advantage for as serving as great trial works, for the instruction of the people in new cultures, in the introduction of new foods, and relieving them from the lazy, dangerous, and total dependence on one. The irrigation with the liquefied manures of cities would moreover have the great advantage, as a culture, of the freedom, experienced here, from the irregularities of rainfall and from droughts, by storage of water reservoirs and the works for ensuring the regularity of the supply of water to the populations of the cities. In some districts of India, as I am informed, the natives have great skill in irrigation, in water leading with plain water, by methods, some of which might be copied at home for leading liquefied manure. It may be mentioned, as illustrative of the working of the pernicious working of the population check, and of the beneficent counter principle of saving life instead of destroying it, that the great obstacle to the progress of the new cultures we are meritoriously introducing into India of coffee, tea, and others, is the want of hands, and yet they die of hunger by thousands!

On the general question of the sanitation of Indian cities, it is to be admitted that according to the descriptions given of some of them, they are so hopelessly bad in the sites and in the surrounding areas, admidst extensive marshes, and in the construction of the houses, that the cheapest course will be one of removal and of reconstructions. When the powers of sanitation, as recited, become known and understood, the like course will be taken with old western cities. We may indeed be said to be beginning already in the like course with bits and blocks of our old towns. But if we are to hold India, it may be submitted that it should be for the Indians, and for their protection against pestilences, as may well be done by utilising trained working military force. In that policy we should keep in view the important example I have cited from Algeria. The Indian military service of the scientific corps have, it is due to mention, afforded instances of great administrators, but little known here, whose achievements, not being of battle or of bloodshed, of "Siva the Destroyer," but of "Vishnu the Preserver," are ungazetted, but who have shown in how short a time the conditions of populations may be beneficially transformed, and who have been positively deified by the poor natives who came under their rule. Let me mention one who, if he had the special light of sanitary science, would have done his work probably even more completely than he did. Major Dixon, of the Bengal Artillery, was sent with a brigade or force to keep in check a robber tribe in the Mairwarra, a hill district about as large as the Highlands of Scotland. He found that from the want of water and the failure of crops they were obliged to make forays on the lowlands for subsistence. He raised capital, made storage-reservoirs, cleared jungles, founded 130 villages, and so engaged that population in productive occupation, that they could not afford to rob. To dispose of the produce raised it was necessary to have a market, and to found a town, and we may be sure that neither town nor villages were fever nests. Instead of spending a revenue, he raised a revenue from that non-productive population; instead of occupying a brigade of force with it, he raised a brigade of force from it, and that brigade was loyal to us at the Mutiny, before which, having completed his good work, he unfortunately died. India has now an incipient sanitary organisation, comprising able officers who have already rendered good services in discovering and displaying the sources of epidemics, and correcting pernicious home errors, as to their rise and spread and the means of their prevention. It would follow that the present delared and accepted policy of the Premier, that the health of the people is the first object of a good government, surely that policy should have commensurate application for the protection of our most afflicted and depressed fellow subjects of the Indian Empire, that they should be rescued from the ravages of the destroyer, and be made to feel that in being brought under the sway of their Empress, our Queen, they are brought under the sway of the preserver.

I beg now to submit a summary of the chief results obtained of the progress of the power of sanitation, deducible from the normal instances I have adduced, or of which, from want of space, I have been obliged to content myself with giving indication for examination:—

1. That we have gained the power of reducing the sickness and death-rates in most old cities by at least one-third; or, as a rule, of reducing the death-rates in old British urban districts to 16 or 17 in 1,000.

2. That in new districts, on sites apart from old urban sites, we may, with a complete arterial system of water supply and surface-cleansing—including measures for the prevention of overcrowding—ensure reduction of death-rates to less than one-half, or to a mean rate of 10 in 1,000, and the sickness in the like proportion.

3. That in well-provided and well-regulated institutions for children from 3 to 15 years of age we may secure them an immunity from the common children's epidemics, and reduce the death-rates to a mean of about 3 in 1,000, or to less by two-thirds of the death-rates prevalent amongst children of those ages in the general population.

4. That in prisons and places under effective sanitary control the death-rates (from disease) have been reduced amongst persons from the school ages and upwards to about 3 in 1,000, or to one-third of the death-rates prevalent amongst the general population of the same ages.

5. That to the persons in such institutions an immunity may be given as against all ordinary epidemics, typhus and the eruptive diseases, diarrhœa, and dysentery, which ravage the general population.

6. That amongst the general population a reduction by full one-half of the diseases of the respiratory organs may be effected by general public sanitation.

7. That complete habits of skin-cleanliness, alone and apart from general structural arrangements, or alterations of habits in other respects, constitute a factor of about one-third of the power of sanitation

8. That by a proper selection and a due sanitation of sites in tropical climates, and the sanitary care of the population, the birth-rates may be made to exceed the death-rates, and a healthy succession, for colonisation, for people of the British or of the white races.

9. That by the increased health and strength imparted by improved physical training under sanitary conditions, on the half-school-time principle, in the infantile and juvenile stages, the efficiency of three for productive occupation may be imparted to every two of the most depressed classes of the population.

10. That the death-rates from disease in the mercantile marine may, by the exercise of the like powers of sanitation that are exercised in the Royal Navy, be re-

duced by two-thirds, or to the general death-rate now prevalent in the Royal Navy, namely, of about six in 1,000.

11. That, as indicated by existing normas, the greatly reduced death-rates in the army at home and abroad admit of important further reductions by a more complete application of tried and approved means of sanitation.

12. That by efficient sanitation the transit of persons from infected places may be most safely effected, and the freedom of trade, including the transit of goods, may be relieved from the obstructions and expensive and vexatious delays of quarantines.

13. That the venous and arterial system for the sanitation of cities is fully demonstrated by increasing varied practice.

That all this may be done admits of more abundant proof than in this Address I have been able to adduce on the present occasion; that all this has been done under conditions that admit of more complete and efficient repetition. On the whole, it will be found to justify the recent most important declaration of the Prime Minister to a greater extent than he has had time or opportunity to be made aware of. I cannot do better than repeat here the terms in which the declaration was made, the highest that has yet come from the head of any Government:—"I have touched upon the health of the people, and I know there are many who look upon that as an amiable, but merely philanthropic subject to dwell upon; but the truth is that the question is much deeper than it appears upon the surface. The health of tho people is really the foundation upon which all their happiness and all their power as a State depend. It is quite possible for a kingdom to be inhabited by an able and active population; you may havo skilful manufactures, and you may have a productive agriculture; the arts may flourish, architecture may cover your lands with temples and palaces; you may have even material power to defend and support all these acquisitions; you may have arms of precision and fleets of fish torpedoes, but if the population of that country is stationary or yearly diminishes, if, while it diminishes in number, it diminishes also in stature and in strength, that country is ultimately doomed. And, speaking to those who, I hope, are not ashamed to say that they are proud of the empire to which they belong, and which their ancestors created, I recommend to them by all the means in their power, to assist the movement that is now prevalent in the country for improving the condition of the people by ameliorating the dwellings in which they live. The health of the people is, in my opinion, therefore, the first duty of a statesman."*

From what is known, I may venture to express a belief, that this declaration is in perfect accordance with the deepest feelings and wishes of her Majesty the Queen.

Sanitary science has had for its first stage simple ignorance and apathy, to which the Premier adverts. Next, its stage of empiricism and half-knowledge, in which stage it is very much at present, with the common result of expensive, misfitting, inefficient, and wasteful works, with water distributions which make good supplies bad, and bad supplies worse; with water carried into houses without the means of removing fouled and waste water, aggravating the evils of damp and excrement-sodden sites; sewers without adjustment to the house drains, intended arteries without relation to the capillaries of the system, leaving undiminished death-rates, serving to encourage the sinister objections that sanitation is of no avail; and lastly, it has the stage of science, of complete knowledge, of unity, efficiency, and economy, tested by reduced death-rates. On these stages I might further dilate. Corresponding with these stages of works are stages of empirical and hasty legislation, of defective administrative organisation, which require distinct exposition as a cause of disaster and waste of money, without equivalent results; and next we must look to more advanced, scientific, and efficient legislation, the outcome due from that study of the means of protecting the health of the people which the Premier has repeatedly declared to be the first duty of a statesman. This of legislation is a topic of large and distinct consideration. I have confined myself to the exposition of the established normas of sanitary power which are available for an advanced legislation and administration to apply. In the support of that advanced legislation we have new agencies for the formation and guidance of an advanced public opinion. In alliance with our association we have the British Medical Association, with an effective joint committee, specially directed to the consideration of the improvement of the local and central organisation of the public health service. Beside these we have new and zealous voluntary associaticns established in the metropolis, and in the course of formation in the provincial cities. We have, moreover, new journals ably and earnestly devoted to the advancement of the public health. The like governmental organisations and voluntary associations are in course of formation and advancement in the United States, in France, Belgium, and Germany. It will be my consolation and reward if the normal examples I have adduced shall serve to give increased confidence and encouragement to our fellow-labourers for the reduction of the greatest afflictions of our fellow creatures.

* Opening of the new buildings of the Victoria Dwellings Association, June 23, 1877.

TECHNICAL EDUCATION.

The following prizes are offered by the Master of the Coachmakers' Company, Charles Saunderson, Esq., for competition among members of the drawing and technical class for artisans in the coach trade of London, held at St. Mark's-buildings, George-street, Grosvenor-square:—First prize (for novelty in the design of a carriage), £8; second, £5: third, £3.

1. The design may be on paper or card board, or may be a model; if, however, a model be chosen for the first, second, or third prize, a further sum of £5 may be awarded to compensate the prize winner for extra time in preparing a model.

2. Each competitor must send a satisfactory certificate that the work is entirely his own.

3. The designs or models must be sent to the secretary on or before May 1st, 1878, each bearing a distinctive mark or motto, accompanied by a sealed envelope bearing a similar mark outside, and containing the name and address of the competitor inside. These envelopes will not be opened until the judges have made their awards.

4. Drawings must be sent in sets of three, showing the side, back or front, and the plan of the design, on not less than an inch scale.

5. The drawings and models will remain the property of the competitor, but may be retained a few weeks for public exhibition.

6. The judges will be nominated by the committee of the class.

7. The carriage or parts of a carriage designed or modelled may be close or open; the novelty may be in shape or construction, or in improved fittings to open the head, or some similar improvement; or in an improved application of a brake retarder, or in carriage springs; or in a more simple and economic method of construction, always bearing in mind that each novelty should be calculated to render carriages more perfect, and to promote the sale of carriages to purchasers, and thus to benefit the whole trade, by creating a greater demand in this and foreign countries.

8. The committee reserve the power of withholding the prizes if none of the works sent have sufficient merit.

The secretary is Mr. G. A. Thrupp, 269, Oxford-street.

CORRESPONDENCE.

THE TELEPHONE.

My attention has been called to a passage in the lecture of Professor A. Graham Bell on the Telephone, reported in the *Journal of the Society of Arts*, for November 30th, 1877, page 22, relative to some experiments made by Sir William Thomson upon interference in the perception of sound. Professor Graham Bell is represented to have stated that the experiments made by Sir William Thomson demonstrated the existence of two phenomena, which may be briefly summed up as follows:—Firstly, that when two sounds of identical pitch are led separately to the two ears, and in identical phases, one sound only is heard in the ears; but when in opposite phases there is a curious difference in the perception, its locality seemingly changing to the back of the head. Secondly, that when two sounds capable of interfering and producing beats are led separately, one to one ear and one to the other, the same effect of beats is produced. In reference to these two phenomena, permit me to observe that both had been previously announced by me in a paper read before the British Association, at Plymouth, on the 16th of August, 1877, and published *in extenso* in the *Philosophical Magazine* of October, 1877. As will be seen by reference to the scientific journals of that date, Sir William Thomson was one of those who took part in the discussion which followed the announcement of the phenomena in my paper at Plymouth. The facts had also been communicated by me, incidentally and briefly, to the Physical Society of London in the month of May preceding. My experiments were made with tuning-forks and india-rubber tubes. The later beautiful demonstrations of Sir William Thomson, have been made with the telephone; and as (so far as I am aware) the details of the experiments have not yet been published by their distinguished author, it is with the greater diffidence that I ask the readers of your *Journal* to compare the results narrated by Professor Graham Bell with those obtained by me last spring. I beg to enclose a reprint of my paper "On Binaural Audition" from the *Philosophical Magazine*, to which I have referred above.

Silvanus P. Thompson,

University College, Bristol, Dec. 20th, 1877.

GENERAL NOTES.

Embossed Wall Papers.—Messrs. Woollams have submitted to the notice of the Society some specimens of embossed flock papers for wall, ceiling, and general surface decoration. The peculiarity of the specimens is that the designs is in high relief, and the surface elaborately modelled. The process by which the papers are produced is that of Mr. Aumonier. The papers are intended to be painted, or to be used without painting, the surface being specially prepared for either purpose.

Working Drawings with Moving Parts.—Messrs. Macmillan and Co. are now issuing a series of drawings, the moving parts of which are represented in stiff, thin cardboard, and are so fitted that they show the motions of these parts. The "Trunk Engine Motion" is the subject of the first drawing published, and in it all the working parts, consisting of the piston, trunk, connecting rod, crank, eccentrics, slide valve, and its connections, are made to move simultaneously on the surface of the sheet. The different parts are all properly jointed by a special joint patented by Mr. Batchelor, the inventor, and, as an example of the durability of diagrams made under this patent, it is stated that they have been subjected to a test of 2,000 revolutions without the least injury. The drawing is mounted on a thick millboard 22 in. by 27 in., and brief directions and description of the engine and movements are given on a sheet covering it.

Sanitary Effect of the Sewing Machines.—A report has recently been presented to the State Board of Health in Massachusetts by Dr. Nichols, regarding the health of people who work with sewing machines. From observations by the medical men engaged it is inferred that a healthy person of average strength who does not make a business of sewing with the machine, may work from three to four hours daily without much fatigue or perceptible injury to health. Among work-people, on the other hand, one frequently meets with disorders of digestion, due to sedentary life and bad ventilation, also pains in the muscles of the trunk and the lower limbs, because these latter are always in motion. There occur also congestions of the ventral organs, weakness, and in some rare cases neuralgias of the legs and spinal irritations. It is recommended to the proprietors of works in which the sewing machine is used, to have (1) a good ventilation; (2) a shorter time for work, with periods of rest; (3) another motor force that of the feet, *e.g.*, a steam-engine.

NOTICES.

THE JOURNAL.

It is specially requested that, in case of any irregularity or delay in the delivery of the *Journal*, notice may be sent at once to the Secretary.

THE LIBRARY.

The following works have been presented to the Library:—

Annual Report of the Boards of Regents of the Smithsonian Institution for 1876.

Radde's International Colour-Scale. Presented by E. Meyerstein.

Paper on the Rolling of Ships, by W. M'Naught.

The Fishes of India, Vol. I., by Francis Day, F.L.S.

The Chemical Composition of Foods, by E. T. Kensington. Presented by the author.

Agendas Dunod, No. 4, Arts et Manufactures Chimie, 1877. Presented by the editor, M. Dunod.

Reports of the Committee of Council on Education, from 1859-60 to 1863-4, and from 1866-7 to 1876-7. Also, Minutes of Committee for 1857-8, and Tabulated Reports of Her Majesty's Inspectors of Schools for 1858-9.

History of the Indian Navy (1613-1863), 2 Vols., by C. R. Low. Presented by Major-General Sir George Le Grand Jacob, K.C.S.I.

Africa, edited and extended by Keith Johnston. Presented by the publisher, Edward Stanford.

Patent Working Drawings. Presented by the publishers, H. and T. C. Batchelor.

MEETINGS FOR THE ENSUING WEEK.

Tues.... Royal Institution, Albemarle-street, W., 3 p.m. Prof. Tyndall, "Heat, Visible and Invisible." (Lecture III.) (Juvenile Lectures.)
Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m. Annual Meeting.
Biblical Archæology, 33, Bloomsbury-street, W.C., 8½ p.m.

Wed.... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Juvenile Lectures). Prof. Barff, "Coal and its Components." (Lecture I.)
Microscopical, King's College, W.C., 8 p.m.
Archæological Association, 32, Sackville-street, W., 8 p.m. 1. Mr. T. W. Grover, C.E., "Roman Fort recently discovered at Beddgelest." 2. Mr. W. G. Black, "Ancient Herbal Folk-lore." 3. Mr. A. Wallis, "Ancient Sculpture in Breadsall Church."
Obstetrical, 53, Berners-street, Oxford-street, W., 8 p.m. Annual Meeting.
London Institution, Finsbury-circus, E.C., 7 p.m. Prof. Barratt "New Views on the Spheroidal State."
South London Photographic (at the House of the Society of Arts), 8 p.m. Popular Meeting.
Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lectures.) Prof. Tyndall, "Heat, Visible and Invisible." (Lecture IV.)
Geologists' Association, University College, W.C., 8 p.m.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,311. Vol. XXVI.

FRIDAY, JANUARY 4, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

DOMESTIC ECONOMY.

The Council, having resolved to hold the Second Annual Congress on Domestic Economy and Elementary Education at Manchester, in connection with the Educational Institutions of Cheshire and Lancashire, in June next, and having learnt from the Mayor of Manchester that he would be willing to act as Chairman of the General Local Committee, and would move the Corporation to give the use of the Town-hall for the Congress, invited the members of the Society resident in Lancashire and Cheshire to form the nucleus of a Local Committee. The members who had consented to serve were summoned to a meeting in the Town-hall, Manchester, on Friday, the 28th ult. Those present were, Mr. C. S. Grundy (Mayor of Manchester) in the chair, the Lord Bishop of Manchester, Sir H. Cole, K.C.B., Mr. Daniel Adamson, Mr. C. Leigh Clare, Mr. John Dodd (Liverpool), Mr. J. Holden, Mr. James Irvine (Liverpool), Mr. Henry Lee, J.P., Mr. Henry Newall, Mr. Peter Spence, J.P., and Dr. John Watts, with Mr. H. T. Wood, Assistant Secretary of the Society of Arts.

The Mayor, in opening the proceedings, remarked that, though the Congress they were about to inaugurate had no high sounding title, and though he could hardly say that the question of Domestic Economy was one of the burning questions of the day, yet the movement was one which would have very important results, and as such it certainly had his sympathies. What they were now engaged upon was but the prelude to something hereafter, and he sincerely trusted that the movement would be in the future fruitful of important consequences. He had pleasure in saying that the Corporation had granted the free use of the Town-hall for the meetings of the Congress, and that the Committee-room No. 4 was at the service of the Committee.

Mr. Wood reported that the Council of the Society, having regard to the fact that the Congress would be held in connection with the Educational Institutions of Lancashire and Cheshire, had endeavoured to secure the assistance of distinguished representatives of those counties; and he announced that his Grace the Duke of Westminster, K.G., had consented to fill the office of President of the Congress; that the Countess of Derby would be President of the Ladies' Committee; that the Lord Bishop of Manchester would serve as Chairman of the Executive Committee; that the Mayor of Manchester would be the Chairman of the General Committee; and that Mr. Oliver Heywood would act as Chairman of the Finance Committee.

It was proposed by the Bishop of Manchester, and seconded by Mr. Leigh Clare, that the following Committees be appointed:—

Executive Committee.

The Bishop of Manchester, *Chairman.*	Dr. Greenwood (Principal of the Owens College).
Mr. R. C. Christie, M.A.	The Dean of Manchester.
Mr. C. Leigh Clare.	Rev. A. McLaren, D.D.
Sir Henry Cole, K.C.B.	Mr. William Peel, *Hon. Secretary.*
Col. Dyer, R.A.	The Lord Bishop of Salford.
Mr. Henry Lee, J.P.	Rev. S. A. Steinthall.

Ladies' Committee.

The Countess of Derby, *President.*	Mrs. S. Fielden.
	Miss Gaskell.
Mrs. George Allen.	Mrs. C. S. Grundy.
Mrs. Burder.	Mrs. Henry Lee.
Mrs. Leigh Clare.	Mrs. C. P. Scott.
Lady Cole.	Miss Slater.
Mrs. Morgan Cowie.	Mrs. Eason Wilkinson, *Hon. Secretary.*
Mrs. Crompton.	
Mrs. T. Dickins.	Mrs. Wood.

With power to add to their number.

Finance Committee.

Mr. Oliver Heywood, *Chairman and Treasurer.*	Mr. F. W. Grafton.
	Mr. T. R. Wilkinson.

Hon. Secretaries.

Mr. William Peel.	Mrs. Eason Wilkinson.

A vote of thanks to the Mayor for presiding, proposed by Sir H. Cole, seconded by the Bishop of Manchester, and carried unanimously, concluded the proceedings.

CANTOR LECTURES.

THE TECHNOLOGY OF THE PAPER TRADE.

By William Arnot, F.C.S., Edinburgh.

Lecture III.—Delivered December 15th, 1877.

Washing, Bleaching, Beating; Loading, Sizing, Colouring.

In my introductory lecture I briefly adverted to the introduction of the "Hollander," or beating engine, as marking an epoch in the history of the paper manufacture; we shall now have to consider at greater length the nature of this machine, and the various operations conducted in it. In our last lecture we prepared our rags, esparto, and wood by boiling for the process of pulping; this operation, or series of operations, is conducted in the washing, or breaking, and beating engines, which, together with the bleaching or poaching engine, are but modifications of the same machine. Indeed, the engines known by the three names, and used for the three purposes, of washing, bleaching, and beating, are identical in principle, the details being only slightly modified. We shall, therefore, study their construction and action together.

The engine consists essentially of an oblong cistern, the ends being circular, partitioned in the centre, lengthwise, so as to leave a space at each end equal to half the diameter of the vessel. In

the bottom, at one side of the partition, is fixed a frame, holding a set of knives, or cutters, looking upwards, and over these revolves a drum, or roll, containing another set of knives, and furnished with the means of adjustment; so that the two sets may either just touch each other, or be separated by some little distance.

The engine is now almost always made of cast-iron, at least in this country, even although it should be intended for bleaching. Many of the older engines were made of wood, sometimes naked, sometimes lined with lead or copper, those intended for poaching or bleaching being generally constructed of slabs of stone, hooped with iron.

Some of the more recently constructed engines intended for washing and breaking esparto, and fibrous substances of a like nature, are of very large dimensions, and have been cast in segments and bolted together, partly for convenience in erecting them, and partly on account of the expense and risk involved in casting such large hollow vessels in one piece. So long as they are strongly constructed, and well put together, there can be no objection to this system. The engines I speak of measure 16 ft. by 8 ft., and 2 ft. 3 in. deep, and are capable of taking a charge of from 8 to 10 cwts. of esparto. Engines of more moderate dimensions, such as 11 ft. by 5 ft., or 9 ft. by 5ft., equal respectively to a charge of 4 cwts. and 2 cwts. of esparto, are cast in one piece. Whatever be the size of the engine, the depth should not be great, from 20 in. to 30 in. being sufficient for even the most capacious.

The bottom of the engine, on the side of the partition in which the roll works, is peculiarly constructed, so as to lead the fibrous material to the cutting or tearing knives, and to promote the flow of the stuff in a constant stream. The frame, or case, in which the stationary knives are fixed, is let into its place through a suitable opening in the side of the engine, the edges of the knives being some inches above its bottom. Between the two levels, the bottom is an inclined plane in the direction contrary to the current, while, in the opposite direction, or with the current, the bottom rises, rather abruptly, to a considerable height above the knives, so as to form a kind of breast facing the roll. Over this breast, or "backfall," as it is called, the stuff, in process of disintegration, is carried by the knives, or fly-bars, set in the roll, which acts as a sort of lifting wheel, while along with the fixed knives it is busy tearing out the fibres. In the inclined plane referred to, a cavity is usually formed, and covered with a perforated plate; this is known by the name of the "sand trap," but it is useful in collecting all kinds of grit, nails, buttons, and similar impurities, some of which would not only impair the quality of the paper if allowed to get to the machine, but would also destroy the fly-bars, or knives of the engine itself.

The knives, which are packed together in a frame, and let into the bottom of the engine, form what is called the bed-plate, and much of the efficiency of the engine depends upon their quality and arrangement. On looking at the construction of the machine which we have before us, it will at once be observed that the stuff in process of being pulped will not all perform its journey round in the same time, that next the partition not having much more than half the travel of that which is near the circumference of the vessel, and, as a consequence, the stuff near the centre will pass more frequently between the roll and the bed-plate and get pulped more speedily. Without some special arrangement to neutralise this action, the pulp produced would necessarily be very irregular in texture. The engineman, with the aid of an oar skilfully applied, can no doubt do much to equalise the result; but no plan dependent so completely as this upon the attention and carefulness of workmen can be relied upon. Apart from any consideration of this kind, the knives are always placed obliquely, so that the action with the fly-bars will correspond to the action of scissors; besides effecting this object, however, the difficulty I have referred to is partially overcome by this arrangement, as the tendency of the rags or stuff is to go towards the forward part of the knives, and if this is next the outside of the engine it will manifestly cause a certain interchange of position to go on continually among the particles. The effect is greatly improved by "kneeing" the knives, so that each half will be oblique in opposite directions, and the forward portion of the plate in the middle of the roll. This improvement, I am told, has also been improved upon, and by increasing the number of knives at the front end of the bed-plate, and putting the "knee" only one-third from that end, better results are said to be obtained. There is another element in this problem which must be understood before we can appreciate the nicety of the study. The roll is, as we have said, adjustable, though in most cases this is but imperfectly done; one end of the roll shaft being fixed, the raising or lowering of the other end necessarily leaves the space between the cutting edges unequal. The irregularity of action to which I have referred is thus further increased, and the tear and wear upon the various parts is, from the combination of circumstances, very irregular.

The knives themselves are variously constructed and put together, but they are generally steel-faced iron plates, packed and bolted into a suitable frame of iron encased in wood. The bed-plate must fit firmly into its seat, as the action between the roll and it, especially when tough rags are being torn up, is very severe. The extent of the cutting surface depends upon the size of the engine and the diameter of the roll; the bed-plate of an engine capable of taking a charge of 10 cwts. of esparto, which I recently examined, contained twelve knives, giving an area of forty-four inches by six. The bars which form the bed-plate of a breaking engine should be about $\frac{3}{8}$ in. thick and laid close together; the face or edge of each being $\frac{1}{8}$ in. thick. Beater bed-plate bars may be lighter, say $\frac{3}{16}$ in. thick, reduced to $\frac{1}{16}$ in. at the face, and separated from each other by plates of zinc $\frac{1}{8}$ in. thick.

The roll to which I have already frequently referred is the complement of the bed-plate, and consists of a heavy cast-iron cylinder mounted on a strong shaft, and furnished with cutting knives or bars similar to those in the bed-plate. These bars are ground flat on the forward side, and bevelled from behind, so as to form good cutting edges one-eighth of an inch thick for breakers, and one-sixteenth for beaters. They are let into recesses cast in the circumference of the roll, and

wedged in with slips of hard wood, the whole being further secured by iron rings let into grooves in each end of the cylinder knives and wedges. The bars are placed in groups or bunches in the rolls; the knives in the groups are about one inch apart, and the groups themselves from two and a half to four inches apart. In breaker rolls two knives usually form a group, while in beater rolls there is the usual number. The roll should fill the space between the side of the engine and the partition or midfeather as completely as possible, to prevent the lodgment of rags or imperfectly comminuted stuff which might get away when the engine was being discharged, and thereby pollute the pulp. The general character of the workmanship will determine how closely the roll can be made to work freely.

The diameter of the rolls of breaking engines range from 33 in. to 48 in., and of beaters from 28 in. to 36 in. The speed of breaker rolls varies from 190 to 220 revolutions per minute. Beater rolls move more slowly, the number of revolutions per minute ranging from 150 to 170. The roll shaft, which must be strong, is carried on a bearing at either end; that at the further side of the engine is usually fixed, while that at the front is capable of adjustment by means of a screw and lever. I have already pointed out the unsatisfactory result of this arrangement, and there can be no doubt that the engines now being made by Bertram, Umpherston, and others, with gearing for lifting both ends of the roll equally and simultaneously, are calculated to do more uniform work and minimise the wear and tear of the knives. The proper adjustment of the roll is of the very greatest importance in the manipulation of all varieties of fibre. The roll and bed-plate should work together accurately to start with, and the slightest touch, more or less, of the adjustment screw, should modify the character of the resulting pulp.

Until within the last thirty years, the driving of the roll was done by cogged wheels, and when George Bertram proposed to drive them with belts, it was averred that such a thing was absurd, and indeed impossible. In 1848, however, the proposal was proved quite practicable, two engines of considerable power having been successfully started at Herbertshire. The advantages of the system are now fully recognised, the tear and wear on the machinery being greatly reduced, less power required, and the work done both increased and improved.

Prior to the date named attempts had, no doubt, been made to substitute belts for gearing, but, unless in the case of poachers, where the roll does little more than keep the pulp moving, the result was utter failure. This was owing to the belts and pulleys being quite unequal to the work they had to do. For one of the large engines I have referred to, the driving pulley should at least be four feet in diameter, while the belt should not be less than ten inches broad. The power required to drive a breaking engine is from 10 to 25 horse-power, and for a beater from 5 to 15 is required. Such, then, is the machine which has contributed so largely to make the paper manufacture the important industry which it now is.

We may now bring forward our boiled materials and charge the engine with them, so that they may be washed and broken in. The engine is filled up so far with clean water, which flows from a sluice placed at the end immediately behind the washer, which I will presently describe. The rags or other materials are put in behind the roll, and are rapidly drawn between it and the bed-plate; the full complement having been got in, it will soon be observed from the altered appearance of the water that the work has already begun. The question now arises, how is the dirty water to be got rid off? This is satisfactorily answered by means of what is called the washer, which is simply a lifting wheel covered with fine wire gauze, and having its discharge at the axis at the side opposite that on which the gearing is fixed. The washer is suspended over the engine and can be raised or lowered into the water at pleasure. When at work it is immersed to the depth of a few inches and kept revolving at the rate of 15 turns per minute. The impure water passing through the fine gauze is caught by the leaves of the wheel as it revolves, and discharged into a suitable trough or gutter. While the washer is kept at work, a stream of clean water, equal to that which the wheel is capable of removing, is allowed to flow into the engine, and as the inflow is immediately in front of the washer it has the circuit of the engine to make before any portion of it can be lifted out again. It is thus brought intimately into contact with the materials passing under the roll as they are being torn and opened out. The impurities are thus effectually got at and removed. The washing is continued until the outflow is nearly as pure as the inflow, and during this time the roll should be some little distance from the plate, especially when esparto, straw, and similar materials are the subjects under treatment. When the tearing out process is carried too far during the washing, a portion of the finest of the fibre is sure to be washed away; the stuff should therefore be opened out only sufficiently to make sure of the impurities being got at, and when these are removed, and the washer lifted, the roll may be put down so as to finish the breaking or tearing, and make the "half stuff" ready for bleaching. The more thoroughly the raw material is bathed or washed, in the boiler or in vats erected for the purpose, and the soluble impurities removed, the shorter time it will have to be washed in the engine, and this is important as there is always a certain loss of fibre in the engine washing, and the longer the process is continued the more serious the loss. So different in this respect is the practice, that washing which takes an hour at one mill is quite as well done in a quarter of an hour at another. The quantity of water used for washing varies in different mills from 1,500 to 2,500 gallons per cwt. of rags, and from 350 to 800 gallons per cwt. of esparto.

The half stuff may be bleached either in the engine in which it has been prepared, or it may be transferred to another at a lower level. This second engine is called the "poacher," the roll of which, as we have already indicated, does little more than mix the stuff and the bleach liquor. The bleaching agent, as purchased by the paper-maker, is called "bleaching powder," and occasionally, though improperly, "chloride of lime." What the precise nature of this agent is, or how to measure its value, we need not at present stay to inquire, as we shall consider these matters

in a future lecture; but what we must understand at present is, that the active agent in the bleaching powder is soluble in water, and, although the substance thus soluble is rather a complex chemical compound, for our present purpose we may safely take it as simply chlorine, or, at all events, as chlorine so slenderly attached to its chemical friends as to be quite easily separated and allowed to act on its own account. The bleaching powder is generally put up in casks containing four, five, or six cwts., and the buyer generally bargains for the casks being of such a size that either one or more of them will charge one of his mixing or dissolving vessels. To be under the necessity of halving casks is neither pleasant for the workmen nor profitable for the mill-owner. The solution is prepared by agitating together so much of the powder and so much water in stone or cast-iron cisterns fitted with agitating arms driven by gearing. Three hours are generally sufficient to dissolve the soluble portion of the powder, and when that is effected, the mixture is allowed to settle for some time. The clear liquor is then syphoned off into stone or slate cisterns. A further quantity of water is run into the mixing vessel, and the lime sediment agitated with it. On again being allowed to settle, a second but weaker solution is obtained, which is run into the same cistern as the previous stronger liquor, and the result of this mixture should be about six or eight degrees Twaddle, at which strength the bleaching liquid is supplied to the poaching engines. The exhausted lime is troublesome to get rid of, as it has no manurial value, and dare not now be put into streams. It is usually drained in ponds or tanks until sufficiently dry to be carted away to a rubbish heap or old quarry. We find an economy in using tanks for draining it, as the drainage can thus be collected and utilised; and in several instances where I have recommended this, from five to ten cwts. of bleaching powder per week have been saved in the mill. A quantity of bleaching liquor, equal to from three to six pounds of 35 per cent. bleaching powder is required to bleach rags, while for esparto the liquor must be equivalent to from eight to ten pounds per cwt.

When the half stuff prepared in the breaking engine is run into the poacher, the water with which it is mixed is lifted out as far as possible by the washer, and the spent bleach liquor from the presses or drainers run in instead. The fresh bleaching liquor required is then measured in, and in from two to six hours the desired effect is usually produced—the pulp having become beautifully white. How this effect is brought about I must now try to explain. In the case of sulphur bleaching, the sulphurous acid combines with the colouring matter without decomposing it, and colourless compounds are the result; but in many cases the bond of union between the elements is so feeble that the sulphur may be eliminated, and the colour restored. In bleaching with chlorine, an altogether different effect takes place; the chlorine does not combine at all with the colouring matter, but either decomposes it, taking away a portion of its hydrogen, or decomposing water in immediate contact with the colouring matter, liberates oxygen in the nascent state, which oxidises the colouring matter to colourless compounds, while the hydrogen combines with the chlorine to form hydrochloric acid. The colour is thus effectually and permanently destroyed. In many mills, and especially when dealing with esparto, the process is completed, as we have already indicated, in the poacher, and to promote this end steam is sometimes introduced, and sometimes also oil of vitriol, or sulphuric acid. Heat is almost invariably a powerful stimulant to chemical action. Sulphuric acid decomposes the chlorine compounds, combining with the calcareous base, and setting the active bleaching agent free to do its work more speedily. The practice of bleaching in stone chests is still carried on to some extent. It is usual, however, to bring up the colour to a large extent in the poacher before running the stuff and liquor into the bleaching chests.

However well managed a mill may be, it is scarcely possible to avoid having a small residue of unused chlorine in the liquid which drains from the bleached stuff, and the rule is to use this in the way I have explained. That as little of this residual chlorine as possible may remain in the stuff when put into the beating engine, powerful hydraulic presses are employed to compress the stuff and squeeze out the liquid. These presses should be large enough to contain easily the whole contents of a poaching engine, and of unexceptional workmanship; the perforated lining especially should be carefully prepared and properly secured. I have seen much trouble from negligent workmanship in this respect. Recently I examined a number of samples of press drainings, and found the unexhausted chlorine to vary very much—from a few grains of bleaching powder per gallon to about an ounce.

The bleached half stuff is lifted off the tray of the press in caked lumps, and is in this condition coveyed in metallic boxes to the beating engines. The first thing to be attended to in the beating engine is the elimination of the last trace of chlorine, which if allowed to remain would injure the size or corrode the strainer plates or wire of the paper machine. There are two methods of effecting this end; the chlorine may be washed out by a copious application of pure water, or it may be neutralised and rendered harmless by some chemical agent. The objections to the washing process are that it takes up the time of the beater, for the roll must not be down while washing is going on, that it uses a considerable quantity of the finest available water, and that fibre is always washed away with the chlorine. None of these objections can be urged against the neutralising process, but objection is sometimes taken to the presence of the chemical agents, added and produced, even although they are quite inactive. I do not think there is much in this objection, as those agents that are soluble pass through the wire of the machine almost completely, while those that are insoluble are in the finest possible state of division, and pearly white. The chemical agent most largely used is hyposulphite of soda, but hyposulphite of lime is also employed, and these agents, known by the name of "antichlore," are put into the engine in such quantity as will ensure the neutralisation of the whole of the chlorine. The products of the reaction, when the soda salt is used, are chloride of sodium (common salt) and sulphate of soda (Glauber's salt), and when the lime salt is used chloride of calcium and sulphate of lime, the

latter identical with the pearl hardening so well known as a loading agent. Upon the management of the beating engine the character of the paper to be produced very largely depends. What is wanted is not a mincing or grinding of the fibre, but a drawing out or separation of the fibres one from another; in fact, the name of the machine indicates pretty accurately the nature of the action required—beating. Long, fine fibres can only be produced by keeping the roll slightly up off the bed-plate, and giving it time to do the work. Sharp action between the roll and the bed-plate will, no doubt, make speedy work of the fibre, but the result will be short particles of fibre only, which will not interlace to make a strong felt. Indeed, the action I refer to will reduce the long, strong fibre of linen to little better than that of wood or straw. Practice and careful observation can alone make a good beater-man, and for the finer classes of paper none but careful, experienced men should be entrusted with the management of the beating engine. Sometimes the operation is conducted in two successive engines, the first being called the intermediate beater, but I have hitherto failed to see wherein the advantage of this system lies. The time usually occupied in beating esparto for printing paper is about four hours, while for rags, the time may vary from four to twelve hours, or even more, according to the nature of the rags themselves, and the purposes to which they are to be applied.

It is while the process of beating is being conducted that the various loading, sizing, and colouring agents intended to be incorporated into it are added to the pulp. To these various ingredients we must now devote some attention.

The practice as to the order or rotation in which the various agents are added, differs quite as much as do the methods of preparing the materials, and the proportions and mixtures used. It is customary, however, to add the loading agents first, and I am clearly of opinion that it is the correct course to follow. China clay or kaolin is the loading agent most abundantly used, and while it is certainly not equal to "pearl hardening" or precipitated sulphate of lime, either in purity or brightness, it is in some respects more suitable for the purpose. It is of a more adhesive nature, and the particles, when viewed by the microscope, show a roughness of surface which no doubt enables the fibre to lay hold of and retain them better than the particles of pearl hardening, which are of smoother exterior. China clay is also specifically lighter, and consequently, not so liable to settle out or go through the wire of the machine, and it has the further advantage of being cheaper than the rival agent. The great bulk of these mineral matters is added to the pulp to reduce the cost of the paper; their cheapness is consequently an important consideration.

China clay is one of the constituents of a disintegrated rock of granitic formation. The separation of the clay from the felspar and other gritty matters is effected by a stream of water, which, depositing the impurities on its journey, carries the finest of the clay forward to settling ponds, where it subsides. The water is drained off, and in course of time the clay becomes dry enough to be packed for transportation. Good clay is soapy or unctuous to the touch, but, unfortunately, the most accurate chemical analysis of it can tell us little as to its suitability for paper-making purposes, and the physical character of the particles of which it is composed really determines its value. A clay may be beautifully white and free from gritty matters, and yet be but ill-suited to the wants of the paper-maker. Those properties are no doubt desirable, but the clay must be of a character to be retained by the pulp on the wire of the machine, and this is precisely the characteristic upon which chemical analysis affords us no information.

Pearl hardening is simply sulphate of lime which has been prepared by precipitation. It is, accordingly, pure, and in an inconceivably fine state of division. It is beautifully white and bright, almost to glistening, and these qualities render it suitable for admixture with the finer classes of writings.

The clay, which term I shall now use in a generic sense, is prepared for admixture with the pulp in the beating engine by agitating it with water in a mixing vessel, a suitable proportion of water being about 30 gallons to the cwt. Steam is used to assist in disintegrating and diffusing it through the water. A small quantity of farina is frequently added to it in the mixing vessel, and when this swells it aids in sustaining the clayey particles in the liquid. Before being used, the clay is passed through a strainer, with the view of removing gritty and other impurities, which, if allowed to get into the paper, would detract from its purity and value. Even the finest china clay is not free from black specks and other extraneous matters, and it is well to use all the precautionary measures available to remove them as much as possible. The clay is measured into the beating engine in such proportion as has been found, by experiment, to give the desired percentage in the paper. This is done almost as soon as the half-stuff has been put into the engine; it, consequently, gets thoroughly incorporated with the fibre before the size is introduced. The normal amount of mineral matter in paper which has not been loaded varies slightly, but may be taken at 2 per cent. When calculating what per-centage of the clay used has been retained by the web, this ought not to be overlooked. Fibre in course of being made into paper will only retain a certain quantity of clay, the quantity being dependent upon the thickness of the sheet, the degree of fineness to which the fibre has been beaten, and the proportion of size used; but this does not seem to be realised sometimes, as we occasionally find makers adding clay to their pulp which can never be retained by the paper, and which is, consequently, thrown away. No doubt, since it has become customary for paper-makers to determine the ash in their papers systematically, much of the hap-hazard sort of work we have seen has given place to a more intelligent method of procedure. That so much mineral matter should have to be used by the paper-maker is much to be regretted. The introduction of some cheaper fibrous material would go far to correct the present unfortunate state of matters. And we must all wish Mr. Routledge success in his search after suitable substances.

The clay having been added to the pulp in the engine, whatever colouring matter may be

required should now be introduced. It is impossible for us to go into a detailed description of the various colouring matters used at the paper-mill, but I may point out that they are divisible into two classes—those which are in solution, like the aniline colours, and those which are insoluble, or in powder, like ultramarine and venetian red. The former class dye the fibre, while the latter coat the surface only. Whatever be the nature of the colouring matter, it should be added to the pulp before the size, so that it may be quite free to impregnate or coat the fibre, as the case may be. When the size has been added, the fibres are in a manner protected from the direct contact of anything that may be afterwards added. Almost all fine papers, including those intended to be quite white, have a certain amount of colouring matter added to them, and it is a matter of great nicety hitting the exact shade or tone that may be required. This is especially difficult in gaslight, and, to meet the difficulty, recourse has been had to the magnesium light, which has proved of some service. I can scarcely omit referring to ultramarine, which is, perhaps, the agent most widely used by the paper maker for giving tone as well as colour to his papers. It is a somewhat complex chemical compound, occurring in an impure state in nature. Until Gmelin succeeded in producing it artificially, the mineral, freed from its grosser impurities, was our only source of supply. It is now produced artificially in very large quantities, but is somewhat expensive and liable to adulteration.

Besides the small quantity of farina referred to as being sometimes mixed with the clay, a much larger quantity is put into many printing and writing papers. Farina is a starch, and on being heated up with water it swells and becomes gelatinous, and when added to the pulp in this state it no doubt acts as a sort of cement, as well as helping to fill up the insterstices among the fibres. Undissolved starch is also sometimes put into the engine, in the belief that, as the wet paper passes over the drying cylinders of the machine, it is heated sufficiently to cause the starch to swell, and thus help to improve the texture of the web, making it closer and smoother. I very much doubt that this effect really does take place. That starch so added does exercise a sizing effect upon paper not otherwise sized we have ample evidence, and this would lead one to infer that the heat had actually produced the effect which we have questioned; at no stage of its journey, however, does the paper attain the temperature which is regarded as requisite to swell starch.

The engine is now ready to receive its complement of size. Writings that are intended to be tub or surface-sized are not usually sized in the engine, but all other writing and printing papers are. The size used in the engine is essentially a resinate of alumina, although doubts have been expressed as to the resin and alumina really being chemically companionised; indeed, some authorities assert that the two agents are but mechanically united. Though this is a point of some interest to the chemist, it does not very much concern the practical paper-maker. The sizing compound, whatever be its precise nature, is produced by adding a solution of alum or sulphate of alumina to a solution of resinate of soda. The reaction between the substances is simple, the sulphuric acid of the alum combines with the soda of the resin compound, producing sulphate of soda, while the alumina and resin are precipitated together. The reaction I have described takes place in practice in the engine. The resinate of soda or resin soap is added first, and thoroughly incorporated with the pulp, the alum solution being added just before the beating is completed.

We are now in a position to consider what the effect of leaving free acid and chlorine in the half stuff would be when the resinate of soda is introduced. The chlorine would at once seize the soda and liberate the resin quite uncombined. In the free state resin is not a friend of the paper-maker, and there can be no doubt that when liberated in the way indicated it is calculated to impair the character of the paper produced to a serious extent. Only the other day, a writer in a German journal points out that free resin is as good a sizing agent as resin alumina, if only it be precipitated in a milky condition. How the paper-maker is to ensure this result the writer does not point out, and I am unfortunately unable to throw any light on the subject.

Acid pulp that is not sized in the engine, must, of course, cut up the strainer plates and wire of the machine, and I have observed that the bars both of the roll and bed-plate of the engine are seriously affected from the same cause, as well as from the use of too much alum or acid sulphate of alumina. This is especially noticeable when the bed-plate bars are separated from each other by layers of zinc, and is, no doubt, attributable to galvanic action. As a rule the loading or colouring matters have no neutralising effect. Washing the bleached half-stuff, or alternatively neutralisation of the free acid by means of some chemical agent, must, therefore, be regarded as important if not essential.

With the nature and valuation of the various chemicals involved in the sizing process I shall deal in the fifth lecture; meantime we must inquire into the preparation of the resin soda compound. Surprise has sometimes been expressed that caustic soda has not been found the best agent with which to treat the resin in the preparation of resin soap or resinate of soda. The explanation seems to be that the action of caustic soda is too violent, the soap produced being essentially different in its nature from that produced by the milder carbonated alkali, and not so readily decomposed by the alumina compound. Crystal soda is no doubt the purest agent that can be used for the preparation of size, but good soda ash is quite suitable and cheaper. Every maker has his own formula for the making of resin soap. The vessel in which the substance is to be prepared should be metal, preferably heated by means of a steam jacket, although in most cases the steam is introduced into the mixture itself. The ash or crystal soda should be dissolved in as small a proportion of water as convenient, and, when boiling, the powdered resin will be gradually added until the requisite quantity has been got in. The whole will then be frequently stirred, and maintained at the boiling-point until the resin is completely in union with the soda. The proportion used may be about two of resin to one of soda crystals, and four to one of good ash. The time

occupied may vary from one hour to six hours. What has to be aimed at is the complete absorption of the resin by the soda, so that none of the former will be left free in the soap. Excess of soda will do no harm, while excess of resin will show itself in the form of specks on the paper. It is consequently safe to err on the side of an excess of soda rather than risk having any free resin in the soap. To test whether the soap has been properly prepared, a sample may be drawn and dropped into a basin of cold water, when it should dissolve readily and completely on being agitated, and if this is done by the hand, the presence of free resin, if any, will be shown by the adhesion of the particles to the hair on the back of the hand. If on applying this test some of the resin be found to be uncombined, and further boiling fails to rectify this, more soda must be added. The resin soap is measured into the engine through a wire cloth strainer in the proportion which is found suitable for the class of paper being manufactured. Experience, coupled with a knowledge of the precise nature of the materials used, and the reactions which result from their application, can alone determine the quantity which it is requisite or desirable to use.

The fibres in the engine having been beaten out to the required fineness, and the requisite loading, colouring, and sizing agents added, the contents of the engine are discharged into the stuff chests or vats in the machine house, where we must, for the present, leave the pulp.

Before concluding this lecture, however, I must not omit referring to the important subject of mixing or blending. Many of our vegetable and woody fibres are ill suited of themselves to make strong papers. Esparto, straw, and wood fibre are frequently mixed in various proportions with longer and stronger fibres—from 5 to 15 per cent. of linen or hemp for example. In the production of fine writing papers the mixing of linen and cotton is also largely practised; and indeed there is no end to the variety of mixtures used for the production of the various classes of paper.

I must also make brief reference to the fact that, besides the beating engine I have described, several other machines for the same purpose have been devised. Perhaps the most worthy of notice is the disc engine, which is, we believe, doing fairly good work in several mills in this country, and more largely in America. There are various forms of this machine, but the essential features of them all are that the work of pulping is accomplished by moving discs, rotating rapidly in close proximity to stationary ones, both being grooved, or supplied with knives or cutting edges, and that the stuff is fed in and discharged in a constant stream. We have not had the opportunity of examining these machines, and cannot, therefore, speak confidently as to their capabilities, but those who have them at work speak favourably of them.

Erratum.—In the second lecture, page 74, first column, fifth line from top of page, for "treated" read *heated*.

In Austria there were granted, in 1872, 921 patents; in 1873, 1,256; in 1875, 1,175; in 1876, 1,295; and during the first half-year of 1877, 547. The number of patents prolonged was 591, 628, 780, 834, 814, and 433, in the several years; the numbers annulled or becoming extinct being, respectively, 669, 745, 1,183, 1,151, 1,186 and 576.

JUVENILE LECTURE.

COAL AND ITS COMPONENTS.

By Prof. Barff, M.A.,

Delivered Wednesday Evening, Jan. 2, 1878.

The lecturer described briefly the supposed formation of coal, and showed specimens which proved its vegetable origin; he then proceeded to notice the different kinds of coal, and explained how they differ from one another in composition. The next subject touched upon was the method by which chemists determine the composition of complex bodies. A brief description was given of what is called proximate analysis; and, in illustration of this, an experiment was performed, which consisted of heating some fragments of coal in a hard glass tube. The products of the decomposition being passed through various receivers, the results produced showed water and coal tar in the first receiver, and in the second the blackening of acetate of lead solution proved the formation of sulphuretted hydrogen, by the destructive action to which the coal had been submitted, thereby showing the presence of sulphur in coal. The gases which issued from the delivery tube were burnt. He next explained what was meant by ultimate analysis, and illustrated this experimentally by burning a piece of coal in a hard glass tube, and leading, by means of an aspirator, the products of combustion, first through a condenser and then through a solution of lime in water; in the first vessel water was condensed, and in the second the lime water became turbid, showing the formation of carbonic acid gas. Towards the end of this experiment pure oxygen gas was passed through the tube containing the hot coal and the action became much more vigorous, and this afforded a place for an explanation of the work which oxygen performs in nature. The general properties of carbon were next explained, and its occurrence in nature in different forms mentioned. The general tests for carbonic acid gas were shown; how it always extinguishes a light, and its action on lime water, rendering it milky by the formation of chalk or carbonate of lime. The existence of carbon in organic matters was shown by acting on a strong solution of sugar by concentrated oil of vitrol, the sugar being decomposed and abundance of carbon being set free, which frothed up and filled the large glass vessel in which the experiment was performed. It was also shown that carbonic acid is breathed out by animals. After this portion of the lecture was concluded, a series of experiments were performed by Mr. Orchard, of High-street, Kensington. This gentleman is largely engaged in condensing gases, especially nitrous oxide or laughing gas, which is used in "painless dentistry." Professor Barff explained how it is that gases can be brought into the liquid condition, and the experiments of Mr. Orchard illustrated this explanation; they consisted first in allowing the escape of liquid carbonic acid from a strong iron vessel, the escaping gas being tested by lime water to prove that it was carbonic acid, it was then allowed to rush out in a long stream, which from its whiteness was clearly visible, next it was allowed to rush into a metal receiver, and when the receiver was opened, a

ball of solid carbonic acid was turned out, which looked exactly like a snow ball. Some of this solid was put into a test tube, and the gas, slowly escaping, extinguished a lighted taper. Mercury was also frozen by a mixture of solid carbonic acid and ether; and the lecture concluded with some experiments with liquid laughing gas, which was exhibited to show a gas in the liquid state, for it is difficult to show carbonic acid in this condition in the lecture-room. The lecture on Wednesday next will treat of hydrogen and some hydrogen compounds obtained from the destructive distillation of coal.

MISCELLANEOUS.

TECHNICAL EDUCATION IN AMERICA.

In view of the prominence into which the question of technical education has recently been brought in this country, it may be interesting to lay before readers of the *Journal* a brief account of one of the most important institutions now existing for the provision of that sort of instruction generally known as technical. The Massachusetts Institute of Technology, at Boston, has developed to the furthest extent the system which is most directly opposed to our own—the system by which the artisan is trained, not only in the principles of his business, but in the actual use of the tools belonging to it, instead of being expected, as with us, to pick up, during his apprenticeship, as much knowledge as he can, alike of the principles and the practice of his trade. It is well known to those who have made themselves familiar with the systems of artisan education adopted in other countries, that the plan of school-workshops has been adopted—more or less successfully—in several Continental countries, the youngest and the most elaborate institutions of this sort in Europe being the Russian technological schools of Moscow and St. Petersburgh. In America, the same system has been gradually coming into favour, until the Philadelphia Exhibition and the specimens of Russian students' work shown there, gave a sudden impulse to its development, and the result was the adoption, at least in one institution, of much of the Russian plan at once. The courtesy of Dr. Kneeland, the secretary, has favoured the writer of this note with a number of documents, giving the history and present position of the institute, and it is from these papers that the following summary has been compiled.

The Massachusetts Institute of Technology, projected in 1861, was established in 1865. It was intended in the first instance that it should comprise a Society of Arts, a Museum or Conservatory of Arts, and a School of Industrial Science and Arts. This scheme seems to have been fully carried out. The Society of Arts was intended to form "a department of investigation and publication, intended to promote research in connection with industrial science, by the exhibition, at meetings of the Society, of new mechanical inventions, products and processes; by written and oral communications and discussions, as well as by more elaborate treatises on special subjects of inquiry; and by the preparation and publication statedly of reports, exhibiting the condition of the various departments of industry, the progress of practical discovery in each, and the bearings of the scientific and other questions which are found to be associated with their advancement." The society now numbers about 350 members, and holds bi-monthly meetings from November to May. The museum was very largely enriched by collections obtained from the Philadelphia Exhibition. It is, however, with the school of industrial science and art, that we are now principally concerned. This seems to have become by far the most important portion of the original foundation, as was indeed very probably intended by its projectors.

As at present constituted, the Massachusetts Institute of Technology "provides a series of scientific and literary studies, and practical exercises, embracing pure and applied mathematics, the physical and natural sciences with their applications, drawing, the English language, mental and political science, French and German. These studies and exercises are so selected and arranged as to offer a liberal and practical education in preparation for active pursuits, as well as a thorough training for the various scientific professions." Ten regular courses have been established, each extending over four years. These are (1) Civil and Topographical Engineering, (2) Mechanical Engineering, (3) Geology and Mining Engineering, (4) Building and Architecture, (5) Chemistry, (6) Metallurgy, (7) Natural History, (8) Physics, (9) Science and Literature, (10) Philosophy.

All these courses are carefully divided, the subjects being classified, so that a certain proportion of them are taken up in each of the four years. For proficiency in any one of the courses, the degree of S.B., bachelor of science, is conferred. Advanced courses of study have also been established recently, and through these the degree of S.D., doctor of science, can be obtained. These courses are open to bachelors of science of the institute "and others of equal attainments." For admission as a regular student to the ordinary courses of instruction, applicants must have attained the age of sixteen, and must pass an examination in mathematics, French, English, history, and geography. For each year's class there is a special examination and a limit of age. Persons not candidates for a degree are required to pass an examination of a somewhat less rigorous character. To the advanced courses, the bachelors of science are admitted without examination. Other persons are admitted on giving satisfactory evidence that they are qualified. Instruction is given by lectures and "recitations," and by "practical exercises in the field, the laboratories, and the drawing-rooms." Progress is tested by frequent oral examinations, and by written examinations held from time to time. At the end of each half-year an examination is held, and the students are compelled to pass these before entering on fresh courses of study.

In the chemical laboratories provision is made for teaching "general chemistry, qualitative analysis, quantitative analysis, assaying, determinative mineralogy, the use of the blow-pipe, metallurgy, and industrial chemistry." During the first term of the first year, besides lectures and "recitations," the student is required to perform a number of selected experiments in the laboratory. In the second term he has instruction in quantitative analysis, both practical and theoretical. In the first term of the second year further instruction in quantitative analysis is given, and to certain classes of students instruction in chemical philosophy. In the second term of the second year, and in the third and fourth years, the principal subjects of study are "volumetric and gravimetric analysis, organic chemistry, gas analysis, the preparation of chemical products, assaying, mineralogy, the use of the blowpipe, metallurgy, and industrial chemistry." A large portion of the time is allotted to work in the laboratories. In the third year courses of lectures are given in quantitative analysis and on industrial chemistry. In the fourth year the lecture-room exercises are devoted to organic chemistry and metallurgy. The students are encouraged to make original researches, and are assisted in so doing.

Physics is taken up by all the regular students in the second year, when the whole subject is discussed in a series of lectures. The various branches are treated both mathematically and experimentally. In all cases, this theoretical discussion of a question is followed by a full account of its practical applications. In the third year the students enter the physical laboratory, and learn the use of different instruments. In the fourth year they

carry out work of a more technical nature, or more closely connected with their professional studies. Here, original investigation is encouraged, and it is stated that the result has been a considerable number of published memoirs. The students also pursue practical courses in photography, lantern projection, mechanical engineering, meteorology, and astronomy. There is a special course of advanced physics for students intending to become teachers.

"Descriptive geometry is taught under the main divisions of planes, developable surfaces, warped surfaces, and double curved surfaces, and each under the subdivisions relative to the kinds of problems treated, of projections, tangencies, intersections, and developments."

The exercises in stereotomy illustrate "a variety of problems in stone cutting, on plane, double curved, and warped surfaces." "The application of descriptive geometry is extended to the construction of the oblique arch and winding staircases of various forms."

In civil engineering, instruction is given in the field as well as in the lecture-room. The use of instruments is taught by actual work in the field. A railway line is surveyed and staked out ready for construction. The necessary computations are all made. An observatory has been erected for instruction in triangulation and geodesy. Problems in designing structures for special requirements are given to the fourth year's class, and, as preliminary to this, a course of lectures on construction is given in the third year. Practical instruction is given in topography and physical hydrography.

Instruction in mechanical engineering is given in three courses, "the mathematical, the practical, and the graphical." Besides this, visits are paid to establishments where machines are in use or in process of construction. Each student has to report on some particular part of a machine or process, and a summary of the reports is afterwards made for the benefit of the whole class.

It is in the department that an experiment has been tried, which is of the greatest interest to those now contemplating the establishment in this country of schools for technical instruction. Following the example of the Russian schools, the institute has established a set of workshops or "mechanical laboratories," for actual instruction in the use of tools. These include a "vice shop," a "forge shop," a "lathe shop," a "planer shop," and a "foundry." At the date of the latest report now in the writer's hands, the three shops last mentioned were not complete, but the first two had been at work for some time.

In the vice shop, chipping, filing, &c., is taught. It is fitted with four heavy benches, each eighteen feet long and three wide. Eight vices are attached to each bench, and it is found that one teacher can readily instruct the thirty-two students thus accommodated. The teaching commences with the most elementary work. The student is given a rectangular block of cast iron, in size $4 \times 2 \times 1\frac{1}{2}$ inches. The two long narrower sides are planed, and on one of them two lines are drawn close to the edge. The task is to file down to these lines and leave a true surface. A certain time is allowed for the completion of the work, the blocks are then sent in, and marks, according to a pre-determined scale, are allotted to the student. Succeeding lessons follow of progressive difficulty. The teaching is given by an experienced gunsmith, and it is stated that no difficulty was found in securing the services of an expert, capable not only of superintending the execution of mechanical work, but of giving instruction in it. So far as this part of the experiment has gone, the results are said to have been most satisfactory. The rapidity with which the students acquired considerable manual dexterity was a source of surprise to mechanics and teachers alike. Indeed, the president speaks of the system as "a triumphant success." How far this gratulatory tone will be justified by the success in after-life of the students, time only can show.

The forge shop is fitted with eight forges. An exhaust blower, connected to the hoods of the forges, carries off smoke and dust, "making this shop one of the best ventilated and most comfortable rooms for work in the institute." It is found that, at all events till considerable skill has been acquired, only one student can with advantage work at each forge. Here also a capable teacher has been found.

"Determinative mineralogy is taught by the study of crystalline forms, and the physical properties of minerals, the use of the blowpipe, and by the handling of specimens."

Geology and palæontology are taught to third and fourth year students by lectures.

Mining is taught theoretically by lectures illustrated by drawings, models from Freiberg, &c., and by practical work in the mining and metallurgical laboratories. The endeavour is also made to give every student during his course the opportunity of joining a party organised for visiting some of the more interesting mining regions. The laboratories are fitted with apparatus for carrying on the various processes of ore-dressing and smelting. "Ores of different kinds may be here subjected, on a small scale, to the same modes of treatment as have been adopted at the best mining and metallurgical establishments." The mills, crushers, &c., are worked by a ten horse-power engine. There are also furnaces, a forge, and other appliances.

In architecture, the object of this department is "to give to its students the instruction and discipline that cannot be obtained in architects' offices." The training of the students "cannot be such as to entitle them to call themselves architects." "It is, however, complete in itself, and not only includes the scientific basis of professional work, giving what an architect needs to know of mathematics, chemistry, physics, geology, and engineering, but gives also as much of more strictly technical knowledge and artistic skill as can be attempted in a school of science." Lectures are given on architectural history, the theory of architecture, ornament, composition, &c. In their last year the students are required to produce original designs for specified purposes. The students have also opportunities for sketching and measuring buildings already erected. The department possesses a museum of photographs, prints, drawings, and casts.

The above include all the courses which may be considered as specially technical.

Besides these regular courses there are special free courses of instruction, established by the trustee of the Lowell Institute. These are open to students of either sex, and are generally held in the evening. The courses include instruction in mathematics, physics, drawing, chemistry, geology, natural history, physiology, English, French, German, history, navigation and nautical astronomy, architecture, and engineering. The only condition seems to be that the candidates must have attained the age of 18. The number of students in each class being limited, the faculty reserve a right of selection.

The subjects for the year 1875-6 were:—(1.) General Chemistry, twenty-four laboratory exercises of two hours each. (2.) Qualitative Analysis, the same. (3.) Philosophy, eighteen lectures for beginners on Kant's "Critique of Pure Reason." (4.) Physiology and the Laws of Health, eighteen lectures. (5.) Heat and its Applications, eighteen lectures. (6.) Perspective, and the Perspective of Shadows, with applications, eighteen lessons. (7.) Light in its Relation to Colour, eighteen lectures. (8.) Elementary German, eighteen lessons.

Free instruction in "Practical Design for Manufacturers" is also given under the same trust. The course includes—"1. Original Design or Composition of Patterns; 2. Secondary Design or Variation of Patterns; 3. Making of Working Drawings; 4. Technical Manipulations." The students learn the art of making patterns for prints, delaines, silks, paper-hangings, carpets, oil-cloths, &c.

Personal instruction is given to each student. Applicants are required to show a knowledge of freehand drawing, and some familiarity with the use of mathematical instruments.

VITICULTURE AT BRINDISI.

Notwithstanding the imperfect manner in which the wine is made, and the low price it obtains in the market, the vine is the mainstay of the commerce of Brindisi. Consul Grant gives a description of the mode of cultivation, and the profits derived from the vineyards. The Brindisi vine, he says, is kept very low, not more than twelve inches from the ground, and without props. The distance between each plant is four feet. It takes six years for a vineyard to become full grown, and by that time it has already repaid more than half the expenses of cultivation, and yields about 24 per cent. During the first six years, it is reckoned that one acre, including the cost of the land, breaking the soil with the spade, planting and cultivating, and the rent of land and loss of interest in capital expended, amounts to £33 10s. The produce during that time would realise £12 3s. 1d., leaving the net cost per acre of a full grown vineyard at £21 6s. 11d. The annual expenses of cultivation would then be £5 9s. 7d., and the value of the produce £9 12s., leaving a net annual profit of £5 2s. 5d. We have, therefore, a full grown vineyard, which has cost altogether £21 6s. 11d., yielding £5 2s. 5d. per acre, or, as already stated, about 24 per cent. The land tax at present amounts to 3s. 2d. per acre.

How is it then, it will be asked, that the whole district of Brindisi is not one large vineyard? It is the scarcity of population that limits this most remunerative culture, which requires more hand labour than any other, all the work being done by the spade. If the vast plains by which Brindisi is surrounded were colonised, the unprofitable cultivation of cereals would soon disappear, and be replaced in great measure by that of the vine, whereby the agricultural wealth of the district would be incalculably increased, for, owing to the growing demand for the article since the opening of railway and steamboat communications, there is no fear of the market being overstocked with wine.

While great care is bestowed upon the cultivation of the vine, no pains are taken with respect to the wine itself, which is generally rough and thick, and altogether of an inferior quality, as its price (2d. a quart) denotes. The red grape, called "Negro Paesano," is what is generally grown, and good wine, not unlike port, ought to be made from it, the more so that it has from 12 to 16 degrees of alcohol, and can therefore be kept any length of time without risk. The system of wine-making is most primitive. Every large vineyard is provided on the spot with a wine-press, which consists of a roofed stone reservoir, from 50 to 66 square feet, and about 3 feet 3 inches deep, communicating, by means of a couple of holes, with two wells capable of holding from 1,000 to 1,200 gallons of must apiece.

The grapes are first put into the reservoirs, where they are pressed by men, who tread on them with their naked feet, and the floor being on an incline the juice runs out into the wells. When the grapes have been thoroughly pressed in this way, nothing but the husks remains in the reservoir, the holes are stopped, and the must is drawn out of the wells in copper buckets and poured back into the reservoir, over the husks. After a couple of hours more pressing, or rather treading, it is left to ferment for about twelve hours. The holes are then opened again, and the must runs out for a second time into the wells. After this the husks are put into a wooden press, and all the juice that can be squeezed out of them goes likewise into the wells. The must is then drawn out and carried in pig skins to town, where it is put into casks of 220 gallons each, which have been previously fumigated with sulphur. The bunghole is imperfectly stopped with a bundle of thyme, and what leaks out is put back into the cask. This goes on until the fermentation is over, when the thyme is replaced by a cork stopper, and the wine is not again disturbed until it has to be drawn for consumption.

The small proprietors labour under the disadvantage of not having wine-presses at their disposal. They either have one in common, or hire the use of one from the larger proprietors. In either case they are unable to choose their own time for the operation, and the consequence is that the grapes generally have to be pressed when they are too ripe or not sufficiently so, to the incalculable detriment of the wine.

CORRESPONDENCE.

BAMBOO AS A PAPER-MAKING MATERIAL.

Having Sir Joseph Hooker's permission, I shall be glad if, in further ventilation of this question, you will publish in the *Journal* the accompanying copy of a letter addressed to Sir Joseph by Mr. Robert Thomson, the Government Botanist, who has so successfully established cinchona cultivation at St. Andrew's, in the island of Jamaica.

It is well known that when the bamboo reaches full maturity, ranging from 40 to 60 years, it flowers, seeds, and dies; thus it occurrs that whole districts in India, where bamboo is in universal use, and almost indispensable for building and other purposes, are deprived of this valuable material, or have to procure it at enhanced cost from other districts, as years elapse before productive clumps available for use are reproduced from seedlings; it is very desirable, therefore, that it should be known, on the authority of so reliable a practical botanist as Mr. Thomson, that not only can the bamboos be rapidly propagated by planting, but, that by judicious cropping, the continuous and reliable supply of such an abundant and valuable paper-making material can be assured.

Thos. Routledge.

Clanheugh, Sunderland, 1st January, 1878.

[Copy.]

Cinchona Plantations, Jamaica,
6th November, 1877.

Dear Sir Joseph,—I have thought of writing you for some time on the subject of your remarks, in your last annual report on Kew-gardens, on bamboo as a material for paper-making. I hope you will excuse the liberty I now take in submitting the views I entertain on this subject. I have taken much interest in this matter, and have been in communication for some time with the largest firm of paper exporters in America, with the object of establishing the export of the raw material from here on a large scale. I have also from time to time, in my reports to the Government, referred to bamboo as being one of the most important paper-making materials. And I may further mention that both the *European Mail* and the *Planter's Gazette* have recently noted the encouraging prospects that exist in Jamaica of establishing a large export trade in bamboo.

Cutting the bamboo stems *en masse*, as you have stated, would undoubtedly destroy the plants, but, with great deference, I would remark that this destruction of the plants can be effectually prevented by the adoption of a different process of cropping. Thus, instead of cutting all the stems simultaneously, a given proportion of matured stems should be retained, and this need only be a small proportion, sufficient to maintain the vigorous action of the roots. The stems thus retained for the preservation of the fructions of the roots may even be moderate in size. Indeed, they may be lopped so as to

superinduce the sprouting of branches and foliage near the ground. Another point to be observed consists in the manner in which the young, succulent stems are cut. They should be cut—that is, the crop for making paper—not close to the ground, but a few nodes above the ground should be left. This plan ensures the sprouting of branches and foliage from some thus left, and maintains the unimpaired action of the roots.

The continuity of supply of the bamboo by the adoption of this plan aggregated to a very considerable quantity each year; and, as has been seen, a bamboo plantation may be kept up indefinitely in regard to time.

I have seen three tons of full-grown stems obtained from a bamboo clump, covering only a few square yards. This would be an enormous quantity per acre. By the system of cropping which I propose, each succulent stem, in that condition in which a penknife is easily passed through it, when dried averages only about three pounds in weight. As many thousands of these are obtainable per acre annually, I feel sure that some ten tons of paper stock could be procured from each acre annually; putting it even at the half of this the cultivation would prove highly remunerative.

The system of reserving a due proportion of growing stems, by which systematic thinnings would be constantly obtainable, is so obviously advantageous, that I think it would entirely supersede the plan proposed by you, namely, growing bamboo like the sugar cane, and to replant after cutting the crop. Bamboo cuttings, though they root immediately, require to be planted a long time, certainly over two years, before they produce large and vigorous stems, suitable for paper making.

It is a pity that some method could not be devised for utilising the ripe bamboo stems in paper manufacture. Some years ago hundreds of tons of the ripe stems were exported from here to America, which stems, I have been informed on reliable authority, were made into paper; this trade was brought to a close owing to some difficulties in the monetary affairs of the merchant in New York to whom the bamboo was consigned. An almost incredible quantity of ripe bamboo is procurable from each acre of land, and I find that the ripe bamboo is used in China for paper manufacture. In a most interesting "Catalogue of the Chinese Imperial Maritime Customs" collection of products at the Philadelphia Exhibition, published by the authority of the Inspector-General of Chinese Maritime Customs, the following account is given of the process of treating the bamboo stems:—"The method of preparation from bamboo is as follows: the bamboo is stript of its leaves and split into lengths of three or four feet, which are packed in bundles and placed in large water tanks; each layer of bamboo is then covered with a layer of lime, water is poured on till the topmost layer is covered. After remaining in this condition three or four months, the bamboo becomes quite rotten, when it is pounded into pulp in a mortar, cleansed and mixed with clean water. This liquid is poured in quantities sufficient for the size and thickness of the sheets required, upon square sieve-like moulds. These sheets (of which a skilful workman can make six in a minute) are allowed to dry, then taken from the mould and placed against a moderately-heated wall, and, finally, exposed to the sun to dry. The best quality is made from the shoots of the bamboo, with alum added to the infusion; the second from the bamboo itself, though a higher grade of this quality is attained by the previous removal of the green portion."

I would add that the prices of paper made from the bamboo in China range from 3 dols. 61 cents to 21 dols. per *pecul* (133⅓ lbs.).

I remain,
Dear Sir Joseph,
Yours truly,
(Signed) Robt. Thomson.

To Sir Joseph Hooker, F.R.S.,
Director, Royal Botanical Gardens,
Kew.

GENERAL NOTES.

Technical Education.—Mr. G. N. Hooper, in a recent address to the Coachmakers' Drawing Classes, made the following remarks on the state of education in foreign countries as regards the coachmaking trade:—"The technical training for young coachmakers in France and other parts of the Continent is far in advance of what is usual in England. Many years ago several of the most intelligent of the coach foremen and workmen in Paris undertook, almost for the love of the craft, to instruct young men willing to learn of their experience. They were enthusiasts, and desired that, as Frenchmen, they and their countrymen should excel. They felt a pleasure in teaching, and, in the course of their teaching, had continually to acquire more knowledge themselves; so that, as draughtsmen, geometricians, and designers, they learnt in teaching. Among the honoured names in this band of pioneers are MM. Zablot, Brice Thomas, and Albert Dupont. Their efforts are bearing good fruit, and they teach in their technical school not only young Frenchmen, but the sons of coachmakers from all the chief cities of Europe. Thus, French enterprise circulates, and leavens other peoples; and, strange to say, almost the only coach builders of Europe who have taken little advantage of such opportunities are the English. Mr. Thrupp and myself visited the classes two years ago, and are able to give evidence of the able teaching and excellent feeling that exists between teachers and pupils, and of the hearty welcome accorded to us when we accepted an invitation to see the work in progress. You have now an opportunity of obtaining some of the advantages offered to foreign workmen. The future of English coachmaking is greatly in your hands; try to maintain England's position. While trade is dull, and you have leisure, prepare for more prosperous times, so that, when trade revives, your heads may be stored with new ideas, your hands trained to execute that which your minds have conceived to be more artistic, and your ideas enlarged to adopt any improved means to promote excellence, either in accuracy, or by saving of time in setting out and executing your work."

NOTICES.

THE JOURNAL.

It is specially requested that, in case of any irregularity or delay in the delivery of the *Journal*, notice may be sent at once to the Secretary.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at eight o'clock. The following arrangements have been made:—

January 16.—"The Manufacture of India-rubber and its Application to Telegraph Purposes." By T. T. P. Bruce Warren, Esq.

January 23.—"The Art of Marbling." By C. W. Woolnough, Esq.

January 30.—"The Art Manufactures of Japan." By Christopher Dresser, Esq., Ph.D.

February 6.—"Higher Commercial Education." By John Yeats, Esq., LL.D.

February 13.—"The Systems of Cremation in Use upon the Continent." By W. Eassie, Esq.

February 20.—"Musical Education at Home and Abroad." By Alan S. Cole, Esq.

March 13.—"The Type-writer." By R. Brudenell Carter, Esq., Member of the Council of the Society.

African Section.

Tuesday evenings, at eight o'clock. The following arrangements have been made :—

January 15.—"Notes Regarding the Zulu Kafirs, and the Probable Influence of the Transvaal Annexation upon the Progress of Civilisation in the Interior of Africa." By Frederick Bernard Tynney, Esq., of the Colonial Service of the Transvaal. (The meeting changed from January 22 on account of Mr. Tynney's earlier embarkation for the Transvaal.) Admiral Sir Erasmus Ommanney, C.B., F.R.S., in the chair.

February 19.—"Egyptian Obelisks and their Relation to Chronology and Art." By Basil H. Cooper, Esq., B.A.

Indian Section.

Friday evenings at eight o'clock. The following arrangements have been made :—

February 1.—"The Destruction of Life in India by Wild Animals." By Sir Joseph Fayrer, M.D., K.C.S.I.

February 22.—"Irrigation Regarded as a Preventive of Indian Famine." By W. T. Thornton, Esq., C.B.

Chemical Section.

Thursday evening at eight o'clock, The following arrangements have been made :—

February 14.—"Recent Improvements in the Metallurgy of Nickel," by A. H. Allen, Esq., F.C.S.

February 28.—"The Chemistry of Infection, or the Germ Theory of Disease from a Chemical point of View," by C. T. Kingzett, Esq., F.C.S.

Cantor Lectures.

Monday Evenings, at Eight o'clock. First Course, on "The Manufacture of Paper," Six Lectures by William Arnot, Esq., F.C.S.

Lecture V.—January 14th.

The Chemicals used in the paper mill; their nature, economical use, and methods of valuation. The recovery and re-use of soda as an economical process and in its sanitary bearings. The disposal of washing and machine waters, so as to minimise the pollution of streams.

Lecture VI.—January 21st.

The various classes of Paper; characteristic differences. The determination of the ash or loading. Water supply. General arrangement and construction of the mill.

Additional Lectures.

A Course of Three Lectures, on "Explosions in Coal Mines," will be delivered by T. Wills, Esq., F.C.S., on the three following Monday evenings, at Eight o'clock, January 28th, February 4th, and February 11th.

Lecture I.—January 28th.

The nature of the Coal Measures. Mining for coal. Ventilation of mines. Composition of coal. Occurrence of fire-damp or marsh gas in mines. Nature and properties of fire-damp. Dangers connected with its presence.

Lecture II.—February 4th.

After-damp or choke-damp. Methods adopted to allow of safe working in fiery mines. Various appliances for lighting mines. The nature of the safety lamp. Different forms of this lamp.

Lecture III.—February 11th.

Connection of the variations of atmospheric pressure with explosions in coal mines. Dangers attending blasting operations in coal mines. Action of coal-dust in certain classes of explosions. The use of the safety lamp as an indicator of the presence of fire-damp, also as a means for its quantitative estimation.

MEETINGS FOR THE ENSUING WEEK.

Mon.... British Architects, 9, Conduit-street, W., 8 p.m. Mr. Horace Jones, "The New Metropolitan Markets."
Institute of Actuaries, The Quadrangle, King's College, W.C., 7 p.m. Mr. Cornelius Walford, "The Scientific Application of Data for Deducing Rates of Premium for Fire Insurance."
Medical, 11, Chandos-street, W., 8.30 p.m. (Lettsomian Lectures.) Mr. Francis Mason, "The Surgery of the Face, Mouth, and Throat." (Lecture I.)
Victoria Institute, 10, Adelphi-terrace, W.C., 8 p.m. Mr. S. R. Pattison, "Limitations in Nature."
London Institution, Finsbury-circus, E.C., 5 p.m. Mr. G. J. Romanes, "Further Researches on the Evolution of Nerves."

Tues.... Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lectures.) Prof. Tyndall, "Heat, Visible and Invisible." (Lecture VI.)
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Photographic, 5A, Pall-mall East, S.W., 8 p.m. Mr. E. Viles, "Photography with the Microscope."
Anthropological Institute, 4, St. Martin's-place, W.C., 8 p.m. 1. Maj.-Gen. A. Lane Fox, "Exhibition of 150 Andamanese and Nicobarese Objects," recently forwarded to him, with a detailed description, by Mr. E. H. Man. 2. Hon. C. Jones, "Notes on some American Bird Mounds." 3. Mr. H. H. Howarth, "The Ethnology of Germany." Part IV. "The Saxons of Nether Saxony," Section II.
Biblical Archæology, 33, Bloomsbury-street, W.C., 8½ p.m. Anniversary Meeting. 1. Secretary's Report, Session 1876-77. 2. Mr. R. Cull, "Memoir of the late H. Fox Talbot, F.R.S." 3. Mr. S. M. Drach, "Is Biblical Poetry Acrostic?" 4. Dr. Julius Oppert, "Revised Chronology of the Latest Babylonian Kings."

Wed.... SOCIETY OF ARTS, John-street, Adelphi, W.C., 7 p.m. (Juvenile Lectures.) Prof. Barff, "Coal and its Components." (Lecture II.)
Geological, Burlington House, W., 8 p.m. 1. Dr. C. Le Neve Foster, "The Great Flat Lode south of Redruth and Camborne." 2. Dr. C. Le Neve Foster, "Some Tin Mines in the Parish of Wendron, Cornwall." 3. Dr. C. Le Neve Foster, "Some of the *Stockworks* of Cornwall." 4. Rev. E. Hill and the Rev. T. G. Bonney, "The Pre-carboniferous Rocks of Charnwood Forest." (Part II.) 5. Mr. W. H. T. Power, "Notes on the Geology of the Island of Mauritius and the Adjacent Islets." 6. M. Ernest Vanden Broeck, "Some Foraminifera from Pleistocene Beds in Ischia." Preceded by some geological remarks by Mr. A. W. Waters.
Graphic, University College, W.C., 8 p.m.
Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m.

Thur.... Royal, Burlington House, W., 8½ p.m.
Antiquaries, Burlington House, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 7 p.m. Prof. H. Morley, "English Novelists of the Nineteenth Century." (Lecture I.)
Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.
Royal Historical, 11, Chandos-street, W., 8 p.m. 1. The Baron de Bogoushevsky, "The English in Muscovy, in the Sixteenth Century." 2. Mr. E. Oakley Newman, "Notes on Druidism."
Mathematical, 22, Albemarle-street, W., 8 p.m. 1. Mr. J. Hammond, "The Meaning of the Differential Symbol D^n, n fractional." 2. Prof. Lloyd Tanner, "Partial Differential Equations, with several Dependent Variables."

Fri.......Astronomical, Burlington House, W., 8 p.m.
Quekett Microscopical Club, University College, W.C., 8 p.m.
Clinical, 53, Berners-street, W., 8½ p.m. Annual Meeting.
New Shakespeare Society, University College, W.C., 8 p.m. Mr. T. Alfred Spalding, "The First Quarto of 'Romeo and Juliet': is there any Evidence of a Second Hand in it?"

Sat.......Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,312. VOL. XXVI.

FRIDAY, JANUARY 11, 1878.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE TECHNOLOGY OF THE PAPER TRADE.

By William Arnot, F.C.S., Edinburgh.

LECTURE IV.—DELIVERED DECEMBER 17TH, 1877.

Paper Made by Hand and by Machinery—The Fourdrinier Machine—Surface Sizing—Drying Machinery—Finishing.

By a series of chemical and mechanical operations, we have succeeded in reducing our various fibrous materials to the condition of pulp, from which we have now to build up another and entirely different fabric. We have seen the disintegration of the original structure very thoroughly effected by means at once simple and readily available. We have now to consider the process of reconstruction, as effected by appliances almost life-like in their action; we have glanced at these in our introductory lecture, now we must look at them more in detail. Previous to the introduction of the Fourdrinier machine, paper was always made in sheets on moulds, the size being regulated by what was known as the "deckle." This was true, whether the paper was made by hand or by machinery, and although the Fourdrinier machine is now making paper at the rate of over a million tons per annum, a considerable quantity is still made in sheets on moulds worked by hand. It has been said that, notwithstanding all the coal gas, and paraffin and other oils consumed for light-giving purposes in our day, there are more and better candles made than there has been at any previous period of the world's history. It is, perhaps, too much to say that, notwithstanding the enormous production of the paper machine, there is as much paper made by hand now as there ever was; but I think it not improbable that at present we manufacture as much paper by hand as the total quantity we consumed a hundred years ago.

That the pulp may be made into paper by hand, it is run from the beating engine into large vats, and copiously diluted with water, which is usually warm. The mixture is kept uniform by agitation, either by means of a "hog," or agitator, worked by steam power, or by an oar or paddle worked by hand. In the case of the finer classes of paper the diluted pulp is purified by sand traps and strainers, just as in the machine process which I shall presently describe. The thickness of the sheet is regulated by the consistency of the pulp in the vats, and by the quantity lifted on the mould. The mould consists of a sheet of fine wove wire stretched upon a frame, and supported on the underside by wires and wooden stays, so that the upper surface may be perfectly flat, and able to bear the tear and wear of the operation. The "deckle," which is a moveable wooden frame, fits accurately over the mould, the under face lying quite flat upon the surface of the wire cloth. Its inside measurements correspond to the size of the sheet required. The wire cloth of the mould immediately under the edge of the deckle is perforated with holes, about 1-16th in. in diameter, to allow the water to escape easily from the edges, and thus facilitate the transference of the sheet from the wire to the felt.

The deckle having been placed over the mould, the whole is immersed in the vat containing the pulp, and the requisite quantity lifted out by the vatman, who is by far the most important man in a "hand" paper-mill. With a dexterous shake the fibres are caused to interlace and settle down into a compact sheet of uniform thickness, the water passing away through the meshes of the wire cloth. Two moulds and one deckle are used by each vatman. As soon as the fibres have fairly settled down, the deckle is removed, and the mould passed to another workman, called the "coucher," whose duty it is to transfer the moist paper from the mould to a sheet of felt. When he lifts the mould upon which the sheet has been made, he turns it completely over, so as to bring the paper to the under side, and then, resting one edge first, he gently lays the mould flat upon a piece of felt which has been placed above the sheet last transferred, presses the paper on the mould and felt together, and, dexterously removing the mould, leaves the paper flat upon the felt. Another piece of felt is placed over the sheet newly laid, and the operation of transferring repeated. While he is thus occupied the vatman applies his deckle to the second mould, and prepares another sheet as before; this is in turn passed to the coucher, who has by this time completed his work with the first mould, and placed it conveniently for the vatman to take up in turn. This goes on until a considerable pile or "post," as it is called, has been formed, when the whole is placed in a hand or power press, and the water squeezed out as much as possible. Having already sufficiently indicated what the after stages of the process as applied to hand-made sheets are, I will not go over the ground again, but proceed at once to a consideration of the more important, because more extensively applied, process of making paper by machinery.

When the stuff is intended to be made into paper by a machine, it is discharged from the engine into what are called stuff chests, which are simply large receivers, built of wood or cast iron, and fitted with mechanical agitators. These agitators move very slowly, so as just to keep the stuff uniform; a higher rate of speed is to be avoided, as it is apt to cause the fibres to work themselves into clots and strings in certain parts of the apparatus. The agitating arms should not be numerous, and should be angular on their forward faces. Each machine should have at least two stuff chests, the size of which will be regulated by the width of the

machine, and the speed at which it is intended to be run. For an 80″ machine, chests about twelve feet wide by six or eight feet deep will be suitable. The engine should never be discharged into the chest from which the stuff-pump is drawing. The stuff as it descends from the engine is not always of uniform consistency, its character in the chest will, therefore, vary during the discharge, and not till the water used to wash down the engine is thoroughly mixed with it will it be safe to draw therefrom. The paper-maker and the public alike want paper of a uniform thickness, and to secure this many precautions are necessary—I have just referred to one of them. Another and obvious difficulty to be overcome is the irregularity of discharge which varying levels in the chest would give, supposing the pulp to flow direct from it on to the machine.

Many and ingenious have been the devices for overcoming this difficulty—pumps and measuring boxes of various kinds, most of them capable of doing their work fairly well, having been applied. What is wanted is a constant head of pressure on the pipe delivering the pulp to the mixing box, and it matters little how this is accomplished, provided the apparatus employed be of the simplest possible construction, with as short pipes and as few bends and corners as possible. The stuff pump now most generally used draws from the chest, and discharges into a box with divisions so arranged that, while an excess of stuff is always discharged by the pump, the surplus will be taken readily away without disturbing the pressure on the pipe going to the machine. Of course the excess stuff lifted by the pipe goes back into the chest. The constant and uniform discharge of stuff of regular consistency thus secured is diluted with a large volume of clean water, or with the water which has drained from the pulp that has already passed over the wire of the machine. This water is usually collected and pumped back for the purpose indicated, and this effects a considerable saving in size, clay, and fibre.

The diluted pulp has first to be freed from sand and other gritty matters, which may not have been removed in the previous processes of preparation, and this is always effected by the simple contrivance appropriately known as the "sand trap." This may be described as a long, shallow tray or trough folded upon itself, serpentine fashion, and having shallow weirs, capable of being removed at pleasure, placed across the current at intervals, so as to retain the heavy impurities as they settle out. By removing the weirs the impurities can be very readily scoured out from time to time.

From the sand trap the pulp passes to the knotters, or strainers, which really form another purifying system, the intention of the strainer being to keep back all knots, insufficiently comminuted fibre, particles of wood, and other impurities of a nature lighter than those removed by the sand trap. It has often been said, with the view of showing the importance of the beating process, that the paper is made in the engine; but I think that, with quite as much force, it might be said that it is the strainer that makes the paper. Every paper-maker knows the importance of having his strainer plates in first-rate order, and, indeed, the whole apparatus involved in this operation must be in perfect condition. With worn-out or faulty plates it is impossible to make creditable paper. These plates are made of brass, of a tough and enduring character, perforated with fine slits at intervals of a quarter of an inch or so. The slits widen out to V-shaped recesses on the under side of the plate, so as to allow the pulp to get freely away after it has passed the gauge. The slits vary in width for the different classes of papers, the finest being a little less than one hundredth part of an inch. The strainer plates are variously applied. They may be formed into flat trays, into which the stuff is run, and through the slits in the bottom of which all that is fit to go to the machine passes, while the knots and other impurities are retained and removed from time to time, or what is better, as in the case of Ibbotson's, constantly removed by the flow of the stuff itself. The plates may also be formed into square on hexagon boxes, and made to revolve in a trough, into which the pulp is constantly flowing. The motion of the strainer itself keeps the pulp uniform while it is being drawn through the slits by suction within. All the varieties depend for their action upon suction, and in the case of trays or flat strainers, a partial vacuum is maintained beneath them by means of a slight though very rapid vibratory motion communicated by a shaft and cam, known as the jog or rapper action. As the plates themselves are slightly higher than the liquid in the vats in which they work, while the ledges which project downward all round are immersed in it, it will be readily understood how the vacuum is produced and maintained. To produce the vacuum the vats must be first filled to a level higher than the plates, then allowed to fall while the surfaces of the plates themselves are kept covered with the pulp constantly flowing on or over them. The revolving strainers are worked differently. George and William Bertram produce their vacuum by means of india-rubber bellows placed inside the strainer, and working horizontally at a high rate of speed. The strainers themselves make from $2\frac{1}{2}$ to $3\frac{1}{2}$ revolutions per minute for esparto, and from $3\frac{1}{2}$ to 5 for rag pulp, while the bellows make from five to seven hundred strokes per minute. James Bertram and Son work their vacuum by means of a suction pump placed outside the strainer vat, whilst Watson and others still further modify the suction and other details. All the arrangements have their good features, and provided the workmanship is unexceptional, any of them may be trusted to do good work.

Ibbotson's flat strainers, and several of the revolving strainers, have auxiliary flat strainers, or knotters, working in conjunction with them. These are placed at a lower level, and receive the knots, &c., from the vats of the revolvers, or the overflow from Ibbotson's arrangement, and completely separate the impurities from any fibre fit for the machine which may have gone down along with them. Whatever good pulp is saved by the auxiliary knotter is pumped back to the chest. When two or more strainers are used with one machine, the stuff is equally divided between them, and, after being strained, is collected again by suitable pipes and connections, fitted with valves for shutting off any one or more of them as desired. The collected discharge from the strainers is conducted into a small cistern or receiver immediately

in front of the wire, and from this it flows over an apron on to the wire itself. This receiver is generally supplied with an agitator, to keep the pulp uniform, and with a sluice, for regulating or stopping the flow. The apron may be made of any strong material that will neither injure the wire, nor get worn out quickly itself by the friction. India-rubber answers the purpose well. The details of these arrangements vary, however, if not in every machine, certainly in every maker's designs.

The pulp, on passing over the apron, reaches the wire, which continually moves forward with the load it receives. The wire and its accessories correspond to the mould of the hand-maker, and is, no doubt, the most important part of the machine; on it, indeed, the paper is actually made. It is an endless band of fine wove wire—sixty to seventy threads to the inch—very carefully woven with tough, pliable wire, so that the mesh may be perfectly uniform throughout, and able to bear a considerable strain. Mr. Green has shown me the record in his predecessors'—Messrs. Brewer and Company—books, of the first machine wires that were made for the Messrs. Fourdrinier, and as the entries have a peculiar interest I have asked leave to give them here:—"1805—August—Messrs. Henry and Sealy Fourdrinier. To 2 endless wires, 20 feet 2 inches by 3 feet 10 inches, contains 154½ feet, at 3s. 6d. per foot—£27 1s. 2d. To 6 rollers, 10s., and box, 4s. September 18—Messrs. Fourdrinier. To an endless wire, 33½ feet by 4 feet 10 inches, contains 161 feet 11 inches, at 3s. 6d.—£28 6s. 8½d. To 3 rollers 8s., box 6s."

The wire is carried at the end next the strainers by the breast roll, the upper surface being further supported by a range of copper rollers co-equal with the width of the wire, but of small diameter, and set close together, so that the wire may form a flat perforated table, upon which the pulp may drain into a perfectly uniform sheet. The under portion of the endless band—or rather the band on its return journey—is carried on large rollers, so arranged that the tension of the web may be regulated by moving them up and down. The rollers carrying the wire all work upon what are called the shake bars, which have a slight lateral motion at the end next the strainers. This motion or shake, which is shared by the wire, diminishes in intensity as the web proceeds, and ceases entirely at the couch roll. This shake is important, as it causes the fibres to arrange themselves so as to form a sheet perfectly homogeneous, and of the maximum attainable strength for the character of the stuff used. The wire, from various causes, has generally a tendency to work itself to one side or other of the rollers, and, if this was allowed to go on unchecked, it would inevitably be injured, and ultimately destroyed. To prevent such a result, a very ingenious arrangement has been adopted, by means of which the wire is kept running within very narrow limits in the centre of the roll.

The width of the web of paper is regulated by what are called deckle straps, which are simply strong india-rubber bands, carried on suitable pulleys, and moving with the wire, on which they lie perfectly flat, thus forming a ledge on either side beyond which the pulp cannot flow. The deckles are adjustable to any width of paper which the machine may be capable of making. Recently, an arrangement known as Holloway's deckle shifting apparatus has been introduced, by means of which the width of the paper being made may be altered without stopping the machine.

When the pulp moving with the wire has made two-thirds of its journey, it reaches what is known as the first suction box. This is placed immediately beneath the wire, and over the perforated top of it the wire slides, making the box practically air-tight. This and the one or two additional suction boxes which come at short intervals after the first, are connected by pipes with air pumps, which maintain them in a state of vacuum. The pressure of the air on the surface of the wet pulp—or paper as it may now be called—as it passes over these boxes, forces the water out with an effect which is quite manifest to even the most casual observer. Between the first and second suction box the "dandy roll' is suspended. This roll is a skeleton cylinder covered with wove or laid wire, adjusted so as to press very lightly upon the damp paper. Depending upon the nature of its surface, its effect is to produce wove, laid, or water-marked paper. A plain roll covered with wove wire of the same nature as the machine wire simply lays down the fibres a little, making the paper slightly more compact; the impression of the wire is very slight, but such as it is, it is the impression of a woven fabric, and the paper formed under it is said to be "wove." When the roll is covered with wire laid lengthwise, and secured at intervals to transverse wires or discs placed in the interior, it is called "laid," and the roll paper impressed by it is said to be laid. I have tried to ascertain who was the inventor of the dandy roll, but find that there is a conflict of opinion about this as about many other inventions. Mr. Couper, of Millhome mill, near Glasgow, is sometimes credited with the invention, but he himself modestly informs me that though he worked out the dandy roll without knowledge or advice from any one, other parties, working quite independently, had at the same time arrived at the same result. When names or devices of any kind are formed of wire, and worked upon the dandy roll, they leave their impress upon the paper; such marks are called water-marks. These water-mark devices were first put upon dandy rolls at Mr. Joynson's mill, St. Mary Cray. The idea seems to have first occurred to Mr. Line, who is still Mr. Joynson's foreman. He stuck some pieces of wire worked into rude designs upon the couch roll, and finding the desired effect produced, transferred them, with soap as a cement, to the dandy roll. It was at once clear that any required lettering or device could be imprinted on the paper in this manner.

Just as the paper reaches the end of its journey on the wire it encounters the upper couch roll, which is a large wooden roller covered with a felt jacket, and kept always quite free from adhering particles of fibre or other impurities by a copious stream of water discharged in jets along its whole length from a perforated pipe. The water is kept from getting to the paper by means of a felt-covered bar, which presses evenly along the entire length of the roll. The pressure of this bar has also the effect of laying the fibres of the felt jacket,

thus sending forward to the paper a surface beautifully clean and smooth. The upper couch roll does not rest, as might be supposed, immediately upon the lower couch roll, but a little behind it. The paper is thus more gently pressed, and indeed the effect is quite different from what it would be if the centres of the rolls were in the same vertical line. The fibres of the web are not crushed together, but gently laid so that the texture of the paper is decidedly improved. The couching done on the machine is quite in harmony with the real signification of the word, though not exactly analogous to the work done by the coucher in the hand process. The length of the wire table upon which the paper is made varies according to the speed of the machine and the quality of paper to be produced. The pulp in any case must have a certain time to drain, consequently if the speed of the machine is great the wire must be proportionately long. Underneath the wire is fixed a shallow tray or save-all for collecting the water draining from the pulp. I have already stated that this water is valuable, and it is utilised in reducing the stuff as it flows from the chest to the sand trap.

The rolls carrying and stretching the wire must all be parallel, and the greatest care must be taken to preserve the wire and its adjuncts in the best of order. With all the care that can be taken, the life of a wire is comparatively brief, seldom exceeding four weeks. The wire is thoroughly washed on its return journey to receive a fresh supply of pulp. Indeed, everything about the wet end of the machine, as it is called, must be kept scrupulously clean.

Almost immediately after passing under the upper couch roll the paper leaves the wire, and, wholly unsupported, bridges over the narrow space between the wire and the nearest part of the first press roll felt, upon which it is received and carried forward to the first press rolls, between which it passes in company with the felt, and is subjected to considerable pressure, the results of which are the removal of a large proportion of the remaining water from the web, the compacting of the fibres, and the communication of the texture of the felt to the under side of the web. This latter effect is of an undesirable character, and one of the objects of the next operation is the erasing of the impression just made. The paper on leaving the first press roll felt passes underneath the second press rolls, and joining the felt of these rolls passes backward between the rollers; the effect of this arrangement, it will be observed, is to bring what has hitherto been the underside of the paper uppermost, and into immediate contact with the naked roller, while the side previously in contact with the metal is now in contact with the felt. The surfaces are thus somewhat equalised, although the paper being drier now the effect of the first impression is never completely effaced; there is also a further squeezing out of water, a further compacting of the web. The uppermost roll of each set is provided with a "doctor," or scraper, which should have a slight lateral travel, and the rolls are thus kept permanently clean.

From the second rolls the paper, now well able to carry its own weight, passes to the drying cylinders, the number, size, and arrangement of which differ in almost every machine. They are usually from 3 ft. to 3 ft. 6 in. in diameter, turned quite smooth and true, and heated with exhaust steam from the engines in the mill. Their number will vary with the character of the paper to be dried and the speed at which it is to be made. A heavy paper and quick speed will manifestly require a much more extensive range of drying cylinders than a slow-moving machine with a comparatively thin web. Almost all the older machines have had their drying power increased, so that they are enabled to run faster, or dry more slowly, which is generally advantageous to the character of the paper. From four or six to ten or twelve cylinders may be taken as the general range, but some large, fast-running machines, such as Lloyd's new 126½ inch one, have as many as twenty. The cylinders are arranged so that the paper in its journey will lap round as large an extent of the circumference of each as practicable. The earlier cylinders of all machines are furnished with felts, which, working over rollers, cling tightly round them, and thus keep the paper to be dried in close contact with the heated metal. The felts, of course, get more or less moist from contact with the damp paper and vapour disengaged, and unless special provision is made for drying them on their journey they must impede the drying process considerably, instead of promoting it, as they are intended to do. Some of the more recently constructed machines have several of the felt rolls made of metal of considerable diameter and heated with steam, with the view of meeting the difficulty I have just indicated. All the felts, both of the rolls and drying cylinders, are provided with stretching or tension rolls and adjustments so that they may be kept at a proper degree of tension. The drying cylinders are sometimes separated into two groups with press rolls between, these are called damp press rolls, and have the effect of decidedly improving the surface of the paper without glazing it. This effect is due to the circumstance that the paper is not quite dry, but just damp enough to yield slightly to the pressure applied.

When the paper has been completely dried, it may or may not be passed through calendering rolls before being reeled; this will depend upon the nature of the paper. If intended for surface-sized writings, it will, of course, be reeled at once; if, on the other hand, it has been engine-sized, and intended for high-class printings, it will be passed through one or more sets of rolls—depending upon the amount of surface required—and then reeled. During the drying of the web the paper gets highly charged with electricity, especially if it has been heavily sized with resin. This is sometimes a source of trouble, as it causes the layers of paper forming the reel to adhere to each other with some energy, and they are thus apt to tear in unwinding, especially if the paper is of a tender description. Various plans have been adopted with the view of dissipating the electricity, the most sensible of which seems to be the interposition of a metallic cylinder, kept cool by a current of cold water, between the calendering rolls and the reel. This arrangement cools the paper and conducts away the electricity. If the pulp has not been sized in the engine, and the paper intended for surface-sizing, the electric development will be but slight;

but, in that case, the cooled cylinder will be of great value in cooling the web, previous to being immersed in the gelatine, which does not adhere well to paper that is warm. The adoption of the Walter and other web-printing machines by the leading newspaper proprietors has necessitated the production of narrow webs of paper tightly reeled in long lengths. Many machines which used to make newspaper paper have had to be turned on to other sorts, being too wide for one newspaper web and too narrow for two widths. When a machine is capable of making two widths, the web has to be slit up, and this may be done either before it has been reeled at all, or the web may be reeled and the slitting done afterwards. Mr. Edward Lloyd's new machine, which is the largest that has been constructed, has an admirable arrangement designed by the makers—Messrs George and William Bertram—for trimming and ripping up the web at once, and winding it into two distinct reels. This is done so well that the ends are as clean and flat as the paper itself, while the layers are so firmly wound that the reel feels like a piece of metal. If the web has been reeled at its full width, it is transferred to what is called a webbing machine, where it is unwound, ripped up, and wound again into two separate webs.

Before finally leaving the Fourdrinier machine, I must briefly advert to the driving and gearing. It is of vital importance that the motive power, whatever be its nature, should be perfectly constant as to speed, as the slightest variation one way or other must inevitably change the character of the paper being produced, the supply of stuff having been regulated, and all other arrangements made for a given speed. If the machine is to be driven by steam, it must have an engine of its own, and if by water, it should have a wheel or turbine for itself, with a constant full supply guaranteed. All machines are arranged so that the speed may be changed within a limited range to suit the different thicknesses of paper. A machine working on writings may run from 60 to 90 feet, while one employed upon news or common printings may run from 150 to 220 feet per minute. The change in speed is usually effected by change wheels, but cone pulleys are also used for the purpose. What is quite as important as keeping the speed of the machine constant is the regulation of the speed of every part; that the paper may be neither dragged or creased at any part of its journey, every part must move in harmony. Allowance must be made on the journey for the change in the length of the web from contraction in drying, and the greatest care must be exercised in keeping the felts, cylinders, and rolls scrupulously clean, for if paper or stuff of any kind be allowed to adhere to a roll, it will, of course, increase the diameter of it, and although this increase may apparently be trifling, still it may be the cause of much mischief. The wire and its accessary rolls, &c., all take their motion from the under couch roll, which is driven by belting from the main shaft. The drying cylinders are geared into each other in one or more groups. The press rolls are driven by belting from the main shaft. The reel is driven by a slip pulley which accomodates itself to its varying diameter.

Some machines used in making paper highly surfaced on one side, and rough off the felt on the other, have only one drying cylinder of large diameter. The making part of these machines is identical with those we have described, the peculiar character of the paper produced being due entirely to the fact of one surface being in contact with heated metal from the time it leaves the press rolls until it is quite dry, while the opposite side never touches metal at all.

Another machine extensively used in America, and also to a small extent in this country, makes its paper on a wire cylinder revolving in a cistern charged with pulp; as the cylinder revolves, the water is drawn through the wire by suction, leaving a layer of pulp upon it. A couch roll rests on the upper part of the cylinder, and as the pulp passes beneath it and becomes partially dried, it leaves the wire, and adheres to a felt which works over the couch roll itself. The pressing and drying arrangements differ but little from what we have already described, the paper produced, however, is essentially different in its nature, inasmuch as the fibres have not been shaken so as to cause them to interlace in all directions, but are arranged in large measure lengthwise in the web. The paper is thus easily torn the length-way of the sheet.

I was a few days ago shown a simple and ingenious arrangement, for preventing the wet end of broken paper from reaching the calender rolls at the end of the machine and clogging them; a source of much annoyance in some mills. The arrangement, which has been devised and patented by Mr. Robertson, foreman at Springfield mill, consists of a lever knife which comes into play and severs the paper when the wet end has passed a certain point on its journey. The falling of the lever also rings a warning bell. The arrangement seems simple and inexpensive, and likely to be useful where the trouble referred to exists.

I have already disposed of our newspaper web, and may, in a few words, dispose of all other printing papers before proceeding to deal with surface sizing and drying. The reels of printing paper which have been made and surfaced on the Fourdrinier machine are taken to the cutting machine, and divided into sheets of any required size. Six or more reels are put on the machine at one time, the ends of the whole of them gathered together and passed through the slitter, which trims off the rough edges and rips up the webs lengthwise into as many widths as may be required. The slitters are revolving scissors capable of being moved to any required position on their shafts. The slit paper almost immediately comes under the influence of the cross-cutters, of which there are two kinds, one cutting while the paper moves onwards, and another which necessitates the stoppage of the paper while it does its work. The former is the one most in favour now, although both are ingenious, and, unless on the score of time, do their work equally well. The cross-cutting action in both cutting machines is that of a moveable blade upon a fixed one, the cutting being progressive from the one end of the sheet right across precisely as in the case of ordinary scissors. The cut sheets are carried to the end of the machine on endless bands or felts, and as they accumulate are removed to the finishing-house, where they are carefully inspected,

and all faulty ones are removed previous to being made up into reams for the consumer.

We must now deal with our reels of unsized paper. It will be remembered that the web was cooled before being wound, so as to enable it to take up the animal size or gelatine more freely. The gelatine used for sizing the better classes of writing papers is precisely the same as that so well known to culinary art. It is the soluble portion of hides, bones, horns, and hoofs, and is extracted from these substances by warm, but not boiling, water in copper steam-jacketed vessels. The raw material most largely used by the paper-maker for the preparation of animal size is what is known as "scrows," which are the pieces trimmed off the hides in this and other countries previous to tanning. These parings may be used fresh, but usually the source of supply is distant from the mills where they are consumed, and this renders it necessary to cure them, so that putrefaction may be prevented. The curing is effected by means of lime, and before the "scrows" are treated for the extraction of gelatine, the adhering particles must be removed, and the material itself softened by steeping in cold water. When the scrows are quite free from lime, and, indeed, restored very much to their original condition, they are put into the copper vessels I have referred to and dissolved. I may fairly say dissolved, for from 5 to 7 per cent. only of the original weight remains in the form of slime when all the gelatine has been removed. To effect the complete removal of the gelatine, two or three successive solutions have to be made, and these are run together into tanks or vats, through strainers designed to keep back slimy and other impurities, which would impair the brightness or otherwise injure the character of the size. The temperature at which scrows should be treated so as to get the gelatine in its purest condition, varies according to the character of the scrows themselves, some varieties requiring a higher temperature than others. It may be taken as a general rule, that the finer the material is, the lower temperature will suffice, and the product will be purer. Inferior scrows are more difficult to dissolve, requiring a higher temperature, and, besides, they do not yield such a pure size. About 140° Fahr. should be sufficient for the finer sorts, and from that up to 180° for inferior qualities. A very small per-centage of gelatine dissolved in water will, on cooling, become solid, but a comparatively short exposure to atmospheric influences, especially in warm weather, will cause it to putrefy and become liquid. To prevent this occurring on the large scale, alum is added to the gelatine shortly after it has been discharged from the dissolving vessels. The immediate effect of the alum is to thicken the size; but the element of acidity is also introduced, as the alum has naturally an acid reaction, and this is no doubt prejudicial to the paper treated. To neutralise this acidity, as well as to improve the size, or facilitate its application to the paper, some paper-makers add white soap to their gelatine. I fail to see what good this does, further than neutralising the acid alum, and, indeed, this neutralising of the alum means more than is generally supposed, for the result of the admixture of the two substances involves the destruction of both. The soda of the soap combines with the sulphuric acid of the sulphate of alumina, forming sulphate of soda, and precipitating the alumina. Of course, the oily or fatty matters which were combined with the soda to form soap are set free, and may have some beneficial, though undefined, effect. It becomes a question of some interest, then, how the gelatine is really preserved from putrefaction when soap is added in sufficient quantity to precipitate the whole of the alumina. It is quite clear that in that case the alum as such no longer exists, and it may be taken as established that neither the sulphate of potass originally associated with the sulphate of alumina in the alum, nor the sulphate of soda, formed by the reaction I have referred to, have any preservative influence. The question just comes to be—Do the precipitated alumina or the liberated oils accomplish this object, or is there really no chemical preservative agent present at all? Of course, it is quite likely that the soap may not be added in proportion equivalent to the alum, and that some sulphate of alumina may be left to exercise a wholesome influence.

The size, on being required for use, is reduced with water and conveyed to the sizing tub, the intermediate arrangements being such as will ensure the tub being kept uniformly full. In the tub, or trough, the length of which is co-equal with the width of the drying machine, there is a roller which takes the web of paper down through the size, so as to saturate it thoroughly. The surplus adhering size is removed from the paper by passing it between a pair of rollers, placed so that the excess will flow back into the tub.

The moist paper now passes on to the drying machine. This consists of a series of skeleton drums, which carry the paper along, while the drying is effected by currents of hot air, rising from a range of steam pipes placed below the machine, and by fans, which revolve in the interior of each drum. The fans move quite independently of the drums, and at varying velocities, the speed being increased just as the paper moving forward gets drier and able to stand greater pressure. The older drying machines consist of one double range of drums, which are geared into each other in sections, while the fans are driven by ropes. The more modern arrangement is to place the drums in three double ranges, one above another, and to drive the drums by belts and the fans by ropes, both in groups, with suitable tension pulleys. The advantages of the new arrangement are, that a machine of great power occupies but little room, that the driving power required is less and more concentrated, and that the heat reaching the paper is better graduated. The web begins its journey along the upper range of drums which are furthest removed from the source of heat, while as it returns along the middle, and finally the lower range, it gets more and more under the influence of the hot air current. Excess of heat is to be avoided all through the operation, and particularly at the beginning. It has been explained that steam heat is not suitable for drying paper moistened by the operation of surface sizing, and heat equally great, though otherwise generated and applied, would be equally injurious.

The sized and dried paper may now be slit up into widths suitable for the web calenders, or may be cut up into sheets in the manner already

described, and glazed by the plate or board calenders. The former method of surfacing or finishing has come extensively into use in recent times, the labour involved being much less than in the older method of finishing in sheets. Still, however, the plate calenders are kept at work upon the higher classes of goods, it being possible to give almost any degree of surface to good paper by that means. There is little doubt, too, that the paper glazed by the plate rolls retains its original softness to a greater degree than that passed through the web calenders. In the latter it is exposed in one thickness to great pressure, and is thinned in consequence, whereas, when the sheets are made up into piles along with copper or zinc plates, there is a certain amount of spring or elasticity in the treatment, which largely counteracts the crushing action of the rolls. The web calenders consist of a series of rollers erected in a vertical frame, and between these the paper winds, beginning at the top and coming downwards, so that the pressure gradually increases as the paper moves on its journey. It will be observed that the under rolls have to bear the weight of the upper ones, and that consequently the pressure on the paper will be the greater the lower down it descends. Many of the rollers themselves are now made of paper, and as these possess a slight degree of elasticity, and take on a high polish, they are alternated with iron rollers with good effect. The paper rolls are made by sliding an immense number of circular sheets, perforated in the centre, on to an iron core or shaft, pressing these together by hydraulic action, and trimming them off on the lathe. The plate or board calenders consist of only two rollers, the upper one heavily weighted, preferably by compound levers. Between these rollers the sheets of paper, alternated with sheets or plates of copper or zinc, and made up into bundles about an inch in thickness, are passed backwards and forwards, the reciprocating action being produced by the movement of a lever in the hand of the attendant. The metal and paper sheets of different bundles may be interchanged, and the process repeated with the effect of increasing the beauty and equality of the finish.

The overhauling, counting, packing, and weighing, are operations into a consideration of which we need not enter. We must, however, before closing refer to the circumstance that when a closer imitation of hand-made writings is wanted, then the processes of sizing and drying, which we have described, are calculated to give, the unsized web is cut into sheets first, and sized afterwards, the drying being effected in lofts, where the sheets are hung up one by one. That splendid paper in every respect can be made by machinery there is no room to doubt. People will have cheap paper, however, and they get it, and complain that it is not like the old hand-made papers. They are right in this, but forget that neither is the price they have paid like that which hand-made papers command.

The West Derby Local Board of Health, whose district is one of the suburbs of Liverpool, utilise the sewage on a farm under their own management. It is stated that the receipts from the farm during the last season had been only £2,853. The year's loss on the farm is stated to be upwards of £4,000, and during its six years' existence the total loss has been about £20,000.

JUVENILE LECTURE.

COAL AND ITS COMPONENTS.

By Prof. Barff, M.A.,

Delivered Wednesday Evening, Jan. 9, 1878.

The second lecture commenced with a few experiments, showing some of the properties of carbonic acid gas, which were omitted the previous evening, owing to the pressure of time; they consisted in the decomposition of carbonic acid gas by passing it through a tube containing red-hot potassium; the gas was decomposed, its oxygen uniting with the potassium, forming potash, and its carbon was deposited in the tube as a black mass. To show its density, carbonic acid was poured from one vessel to another, as water is poured; and a small air ball was placed in a tall jar, half full of carbonic acid, when on reaching the gas it remained on its surface, suspended as it were in the centre of the vessel. The lecturer then gave a description of the hydrogen compounds which can be obtained by heating coal out of contact with air, and first he explained the nature of pure hydrogen, how it is obtained from water by electrolysis, how also, from the same source, by the action on it of metals at different temperatures. He placed a small piece of potassum in water, which immediately decomposed some of it, the hydrogen which was set free catching fire and burning with a violet-coloured flame. He also explained briefly the action of red-hot iron on steam. After this, hydrogen was prepared in the ordinary way, by the action of zinc on oil of vitriol diluted with water. To show the lightness of this gas it was collected by upward displacement; also, a balloon filled with it ascended to the ceiling of the lecture-room. The non-luminosity of the hydrogen flame was illustrated, and the gas used in this experiment was afterwards passed through a vessel containing benzole, whereby it was rendered intensely luminous. This gave occasion for an explanation of how gases hold liquids in suspension, and how coal gas is rendered light-giving by the presence in it, and by the combustion of, certain liquid hydrocarbons set free in the manufacture of coal gas. A miniature explosion was produced by a mixture of coal gas and air, showing the danger of allowing this gas to escape into rooms, and then bringing a light into contact with it mixed with air. A gas containing carbon and hydrogen, called olefiant gas, was next made, and several experiments performed with it to show the luminosity of the flame produced by burning it. Its power of uniting with chlorine and bromine was demonstrated, and an experiment was performed by passing coal gas through bromine water, which, originally brown, was discoloured by the gas, showing the presence in it of olefiant gas; thus proving that olefiant gas is a constituent of coal gas, and therefore a product of coal. Marsh gas was next spoken of, but was not prepared, owing to the short space of time at the lecturer's disposal. The composition of another compound of carbon and oxygen, which is obtained from coal viz., carbonic oxide, was given, and some of the gas burned to show its

characteristic blue flame, so well known as flickering over the surface of a bright and smokeless fire. The lecturer was assisted by Mr. J. H. Pearce, B.Sc., Lond.

MISCELLANEOUS.

RAILROADS AND MINES IN THE ISLAND OF SARDINIA.

The Island of Sardinia, since it has felt the benefits of liberty, promises to take a course of progressive activity which, if assisted and favoured by the Government, the province, and communes, must in a short time reach the flourishing state of the other provinces of the Italian kingdom most advanced in civilisation, industry, and commerce. Consul Pernis states that one of the most effective means for this purpose is the construction of common roads and railways. Formerly, Sardinia had no carriage roads, but only narrow, tortuous, and broken paths running across marshy ground, that frequently rendered them impracticable in the winter season. From this deplorable state of abandonment it acquired that terrible, isolated condition in which several centres of population, although favoured by nature, by the fertility of their soil, and the application of labour, were often obliged to see the products of their land rot, after supplying the local consumption, not being able to sell them for lack of means of communication.

Sardinia was endowed under the Roman Empire with a network of roads, as is attested by remains of roads and ruins of bridges still visible in several localities, but it was entirely neglected by its succeeding rulers, and, under the feudal dominion, especially, it was oppressed by all sorts of impositions and burdens, as the only aim of such governments was to keep the island in a perpetual state of vassalage, in order to render it powerless and more easily extorted. It was under the dominion of the Royal House of Savoy, and after the initiative taken by King Charles Felix, that the necessity was again felt of supplying the interior of the island with means of communication, and in the year 1830 the first national road was constructed, improperly called central, which, departing from Cagliari, touching at Oristano, crossing the regions of Macomer, Bonorva, and Terralba, reaches Sassari, from whence it extends for a few kilometres more as far as Portotorres. With this longitudinal road stretching from one cape of the island to the other, it may be said that the first door was opened towards progress and civilisation; the former, in that time a very important economic fact, aided the latter; and further, more important and greater contemporary with it was the establishment of a regular line of postal steamers touching at the two extreme ports of the island. Thus the Continental provinces, and particularly the most commercial port in Italy, Genoa, were brought into a more easy and mutual intercourse with the two sister cities of the island, Cagliari and Sassari.

For a long time the island remained with this single road, and it was only after its connection with the Piedmontese provinces, or, rather, after it felt the advantages of a free constitutional Government, that this principal want began to be provided with some interest. The question was finally solved, when Sardinia, wishing to put itself on the same footing as the other provinces—and its claim was by all means just—demanded to be endowed with a railway, which, putting in communication the extreme points of the island, would facilitate the communication of the southern part with the Italian Continent, and specially with Rome. On the 14th July, 1862, a convention was made with an English company, in force of which the same acquired full possession of one-half of certain property, under condition of constructing the net-work of railway for a proportionately established kilometrical indemnity, and the other half of the said property devolved in full possession to the communes. But since the law of January 4th, 1863, which approved that convention for the construction of the lines Cagliari-Iglesias, Cagliari-Oristano, Oristano-Ozieri, Ozieri-Portotorres and Sassari, and Ozieri-Terranova, for an extension of 338 kilos., which ought to have been completed and put in working order within six years, the only branches yet constructed are the so-called Cagliari-Iglesias, Cagliari-Oristano, Sassari-Portotorres, and Sassari-Ozieri.

Although Sardinia has felt for the last two years a most severe commercial crisis—a crisis which does not show yet any signs of finishing—nevertheless the carriage by goods trains shows a surprising increase; in fact, in three years there has been an increase of 34,000 tons, with an increase of revenue of 93,799 lire. The increase of carriage shows evidently that the railways will contribute greatly to the economical development of the island, for, as the communes gradually complete the obligatory roads to put themselves in communication with the railway, the goods rush to the stations, although the tariff of the Sarde Railway is not such as to draw them thither. When all these new ways of communication are opened, the cultivation of the mines will become easier, and the necessary increase of population will remove the insalubrity of the climate, for, owing to the abandonment of the accumulated torrent waters, there are long extensive zones, deserted of inhabitants, although fertile and capable of improvement.

One of the circumstances which has had a great influence in improving the climate has been the exploitation of mines on a large scale. It has been verified, through the establishing of mining colonies naturally founded by private enterprise only, that whereas during the first period of the working of each mine they proved to be the tomb of the few workmen employed in them, now, instead, thousands of workmen reside there without being molested by frequent cases of fever, the hospitals and the different sanitary services organised in those mines having contributed towards diminishing the fatal effects of the malaria. During the season of 1875-76, Consul Pernis gives the total value of the products of the mines at 13,390,991 frs. The bulk of these mines, to the extent of 37, produced argentiferous lead ore, galena, and carbonates of lead, whilst seven were engaged in the production of iron, manganese, nickel, cobalt, bismuth, lignite, and anthracite.

FISHERIES OF GHILAN.

Through the courtesy of the Russian authorities at Resht, Consul Churchill had the privilege of inspecting the large fishing establishment of Mr. Leonozoff, which has been in operation for several years by a concession from the Persian Government. During the fishing season, which begins in December and ends in March, Mr. Leonozoff employs 1,100 men in Ghilan, the greater part of whom are Russian subjects of Bakou and Lenkoran. Out of this number 350 are employed at Enzelee, and the remainder on the Sezidrood, where sturgeon is mostly caught, and along the coast.

At Enzelee the establishment looks quite like a Russian settlement, with its shipwrights and blacksmiths, its glove and bootmakers, its huts for the men to sleep in, and its comfortable wooden house, constructed in Astrakhan, and brought out in pieces for the manager. Along the sea-shore are vast shanties on piles projecting into the sea, and under these shanties the fish are thrown in thousands out of the fishing boats. One by one they are shovelled or pushed before a gang of men squatting

down in a row, with knife in hand, who rip up the fish with remarkable dexterity and little loss of time; they take out the inside and push the fish away behind them. They then separate the roe from the entrails and throw the latter into the sea through holes in the platform on which this operation takes place. The fish is then thoroughly washed and carried into the salting houses, where it is covered with salt by men wearing large leathern gloves, to protect their hands against the effects of the salt; it is then sorted and packed into large vats. At Enzelee the fish mostly caught are the sefid mahee, the reppour (a sort of carp), the soof, the somme (four feet in length, with an enormous head and no scales), the salmon, and the salmon trout. Vessels of about 160 tons are in readiness alongside to take in cargo, and after remaining some time in the vats the fish are taken out and carried off to the vessels; there they are re-salted and re-packed in the hold. A vessel has to remain some months before it can take in a full cargo, as the weight of the different layers makes the fish settle, and creates more room.

The salt employed in these operations is brought over in blocks from Teheleken, an island in the neighbourhood of Krasnavodsk; there were crushing machines lying about on the premises, but it was evidently found more simple to break up the blocks with the hammer and sift the salt afterwards. On the Sefidrood, the most important river in Ghilan, where upwards of 600 men are employed, the principal catch is sturgeon, which produces the roe known as caviar. This is likewise salted, but in a more delicate manner, and sent to Astrakhan in casks, where it is put into tins. The isinglass is cut out of the spine of the fish, and the remainder is salted for the Russian market. The roe, called argotarako in Greek, or boutargne in Italian, so much prized in the East and in Italy, is also produced on these shores. Some of the fisheries are sub-let by the contractor to the natives for the local supply, which is principally the sefid mahee; the Persians are very particular as to the fish they eat, rejecting anything without scales as unlawful.

There is a vast wealth in the rivers of this coast that has not yet been explored. Implements for catching the larger description of fish are alone used, the smaller kinds being disdained. Of these there are several sorts that, together with their larger kindred, ascend the rivers to spawn. These naturally pass unmolested through the traps and nets laid for their larger companies. Mr. Leonozoff makes no secret of its being a very lucrative business, and it is said that £80,000 is the least that can be put down for the fish exported by him, on which he pays no export duty, in virtue of a special clause in his contract to that effect.

The quantity of wild ducks caught in the estuaries along the sea-shore is considerable; they are entrapped in nets at night, allured to the fatal spot by decoy birds, and with the aid of lights in small canoes. They are killed in the orthodox Mussulman fashion, and after having been plucked, are sold at the low rate of 4d. the couple. 4,000 tomans is the money value of this branch of trade. Grebe skins have recently been in little demand, and they have, moreover, become scarce in these parts from the grebe having been too much hunted down in previous years.

THE TALKING PHONOGRAPH.

The *Scientific American* gives the following account of Edison's phonograph, or talking telephone:—

Mr. Thomas A. Edison recently came into this office, placed a little machine on our desk, turned a crank, and the machine inquired as to our health, asked us how we liked the phonograph, informed us that *it* was well, and bade us a cordial good night. These remarks were not only perfectly audible to ourselves, but to a dozen or more persons gathered around, and they were produced by the aid of no other mechanism than the simple little contrivance explained below.

The principle on which the machine operates we recently explained quite fully in announcing the discovery. There is, first, a mouth-piece, across the inner orifice of which is a metal diaphragm, and to the centre of this diaphragm is attached a point, also of metal. This point rests against a brass cylinder supported on a shaft which is screw-threaded, and turns in a nut for a bearing, so that when the cylinder is caused to revolve, it also has a horizontal travel in front of the mouthpiece. It will be clear that the point on the metal diaphragm must, therefore, describe a spiral trace over the surface of the cylinder. On the latter is cut a spiral groove of like pitch to that on the shaft, and around the cylinder is attached a strip of tinfoil. When sounds are uttered in the mouth-piece, the diaphragm is caused to vibrate, and the point thereon is caused to make contacts with the tinfoil at the portion where the latter crosses the spiral groove. Hence, the foil, not being there backed by the solid metal of the cylinder, becomes indented, and these indentations are necessarily an exact record of the sounds which produced them.

It might be said that at this point the machine has already become a complete phonograph or sound writer, but it yet remains to translate the remarks made. It should be remembered that the Marey and Rosapelly, the Scott or the Barlow apparatus, which we recently described, proceed no further than this. Each has its own system of caligraphy, and after it has inscribed its peculiar sinuous lines, it is still necessary to decipher them. Perhaps the best device of this kind ever contrived was the preparation of the human ear made by Dr. Clarence J. Blake, of Boston, for Prof. Bell, the inventor of the telephone. This was simply the ear from an actual subject, suitably mounted, and having attached to its drum a straw, which made traces on a blackened rotating cylinder. The difference in the traces of the sounds uttered in the ear was very clearly shown. Now there is no doubt that by practice and the aid of a magnifier, it would be possible to read phonetically Mr. Edison's record of dots and dashes, but he saves us that trouble by literally making it read itself.

The reading mechanism is nothing but another diaphragm held in a tube on the opposite side of the machine, and a point of metal which is held against the tinfoil on the cylinder by a delicate spring, so that the metal point is caused to vibrate as it is affected by the passage of the indentations. The vibrations, however, of this point must be precisely the same as those of the other point which made the indentations, and these vibrations, transmitted to a second membrane, must cause the latter to vibrate similar to the first membrane, and the result is a synthesis of the sounds which, in the beginning, we saw, as it were, analysed.

In order that the machine may be able exactly to reproduce given sounds, it is necessary, first, that these sounds should be analysed into vibrations, and these registered accurately in the manner described; and, second, that their reproduction should be accomplished in the same period of time in which they were made, for evidently this element of time is an important factor in the quality and nature of the tones. A sound which is composed of a certain number of vibrations per second is an octave above a sound which registers only half that number of vibrations in the same period. Consequently if the cylinder be rotated at a given speed while registering certain tones, it is necessary that it should be turned at precisely that same speed while reproducing them, else the tones will be expressed in entirely different notes of the scale, higher or lower than the normal note as the cylinder is turned faster or slower. To attain this result there must be a way of driving the cylinder, while delivering the sound or speaking, at exactly the same rate as it ran while the sounds were being recorded, and this is perhaps best done by well-regulated clockwork. It should be understood that the machine is at present in

dn experimental form, and combines in itself two separate cvices—the phonograph or recording apparatus, which Produces the indented slip, and the receiving or talking contrivance which reads it. Thus, in use, the first machine would produce a clip, and this would, for example, be sent by mail elsewhere, together in all cases with information of the velocity of rotation of the cylinder. The recipient would then set the cylinder of his reading apparatus to rotate at precisely the same speed, and in this way he would hear the tones as they were uttered.

THE PRODUCTIONS AND INDUSTRIES OF THE PROVINCE OF FORLI.

The province of Forli is situate on the eastern slopes of the Appenines, of which it occupies the lower part (the summits being included in the provinces of Florence and Pesaro), together with the plain stretching down to the shore of the Adriatic. The natural road, on the line of the ancient Flaminian and Emilian ways, forms the line of separation between hill and plain, while it links together the lower villages built on the upper edge of the latter, generally at the outlets of the principal valleys. The province boasts that through its territory flows the river Rubicon, of which three streams, the Pisciatello, near Cesena, the Fiumcino, which bathes Savignano, and the Uso, passing by St. Arcangelo, dispute the honour of being the modern representative.

The territory of Forli is bounded on the north by the province of Ravenna and the Adriatic Sea, on the east by the province of Pesaro, on the south by the same province, the republic of San Marino, and the province of Florence, and on the west by this last and the province of Ravenna. The population was 224,463 souls in 1861, and 234,090 in 1871, showing an increase of 4·29 per cent. in ten years. The total increase of the whole kingdom during the same period was 7·10 per cent. The increase has taken place in the rural rather than in the town districts of the province. There are three ports, Rimini, Cesenatico, and Cattolica, situate in the flat coast line of the Adriatic, and of which Rimini, the head-quarters of the maritime department of the same name, is the most important. These ports are formed of embanked canals, the continual prolongation of which is rendered necessary for the two first by the gradual receding of the sea at the rate of about one metre per annum. At Cattolica, on the contrary, the sea appears to be advancing. Of late years Rimini has become a favourite resort for sea-bathing. Counts A. and B. Baldini first erected a sea-bathing establishment as a private speculation. After having overcome great difficulties, these gentlemen have the pleasure of seeing their scheme a success and energetically carried on by the municipality. No pains are spared to render the baths popular, and the number of visitors appear annually to increase. The bathing season is during the summer months.

The province is considered to be among the richest in Central Italy, not only for ferlility of soil, but for the abundance of mineral wealth. While much still remains to be done, the system of the agriculture is steadily, if slowly, improving. In the hill districts, however, it is very defective and carried on by primitive methods. Sufficient attention is not paid to the raising of stock, although the lower hills are well adapted for the production of forage. In that portion of the province which extends through the lowlands to the sea, combined efforts might be advantageously made for promoting drainage work. But to execute these improvements capital is required, and complaints have been addressed to the Minister of Agriculture of the heaviness of taxation oppressing the farmers, and of the system of land credit which, as at present regulated, does not yield the benefits anticipated from it. The land is cultivated under the metayer system, which, however socially advantageous, is said to require serious modifications, to enable it to meet the needs of modern agriculture. The tenancies vary in details, not only in the different districts, but even from commune to commune, and almost from estate to estate, a want of method full of inconvenience. The system of tenancy necessarily limits the size of the farms. The principal productions are wheat, Indian corn, and other cereals, oats, beans, peas, and potatoes, wine and oil, hemp and silk, fruit and vegetables. The cultivation of the hop was introduced in 1850 by Mr. Pasquali, who brews, it is said, good beer, though not on a very large scale. The woods have been greatly cut down on the hills, and there seem to be few, if any, attempts at re-wooding. The principal species of trees appears to be different kinds of oaks (*Quercus ilex*, *Q. robur*). The condition of the agricultural population is said, on the whole, to be prosperous, with some temporary exceptions. Distress, when it exists, is in great part to be attributed to the long continuance of the silkworm disease, and, particularly at the present time, to the failure of the vintage; silk and wine are both articles of serious importance to the Italian peasant.

The vine is cultivated throughout the province. In the district of Cesena the vines are grown "a filone," "a vigneto," "a vignolo," and in the borders of the district of Forli and Rimini "a maglio." In the first system a single line of vines is planted at intervals among other cultures, an elm tree (*Ulmus campestris*) being generally placed at every six metres. By the second, which prevails chiefly in the hills, a regular vineyard is formed; the third method is a gradual amplification of the first into the second, when the land between the rows of vines is unsuited to cereals, or forage, and is also in use in the hill district. In the system "a maglio," the vines are trained to the elm trees, in alternation to which the vines are planted, the spaces between the rows being occupied by other cultures. Wine making, with few exceptions, appears to be still in its infancy, though there is no doubt that excellent wines could be produced of good strength and flavour.

The silk husbandry is continually on the increase, and the markets are becoming yearly more important. Generally, the silkworms are bred by the metayer on the farm; the farmer provides all the utensils required, as well as the labour, while the proprietor purchases half the eggs and half the leaves required to feed the worms, if the farm does not produce a sufficient quantity. When the cocoons are sold, the profits are equally divided between the two. In some parts in the neighbourhood of Forli, for example, should the proprietor prefer selling his leaves to rearing silkworms, he forbids the metayer to keep the latter, and sells the first to his own exclusive profit. Elsewhere, as at Medola, a neighbouring commune and an important centre of the silk industry, the profit from the leaves is equally divided between landlord and farmer. The mulberry cultivated, Consul Colnaghi states, is the *Morus alba*, of which there are many varieties. Planted the preceding June, the young trees are disposed of in the following spring by the market gardeners (to whom this industry is confided) to the farmers, who plant them in a nursery, commonly termed the "boschetta," at from 80 to 100 centimetres distant from each other. The seedlings are kept in the nursery for three or four years, when they are definitely transplanted to their proper place along the sides of the fields, or round threshing floors, as marking the boundaries of the farm. The trees stand in line, at a distance of from six to seven metres from each other. They are generally all grafted. In May, after the worms are reared, the trees are carefully pruned, but are not polled, as is usually done in North Italy, a practice condemned in this province.

The province exports silk, raw hemp, fruit, cereals, wine, and sulphur, receiving in exchange hardware, colonial produce, metals, manufactured goods, coal, firewood, &c. The balance of trade, although from the absence of positive statistics it cannot be proved, is said to be in its favour.

ADULT INSTRUCTION THROUGH PUBLIC MUSEUMS.

(Subsidised by Parliament.)

The following results, giving important information bearing on public education, are obtained as correctly as possible, from inquiry and Parliamentary returns, in the hope that they may hereafter be officially collected and published periodically, like the Registrar-General's returns. The number of visitors for the months of November and December, 1877, are stated. When they are counted by sight the letter "S" is used, when by turnstile the "M":—

INSTITUTIONS.	Amounts voted in 1877.	Number of Visitors in November.	Number of Visitors in December.	How counted.	OBSERVATIONS.
1. British Museum	£ 109,990	35,157	87,665	S	Return refused. Open Mondays, Wednesdays, Fridays, and Saturdays. Closed, except to students, on Tuesdays and Thursdays. (1)
2. National Gallery, Charing-cross	6,976	44,727	80,039	S	Open Mondays, Tuesdays, Wednesdays, and Saturdays. Closed on Thursdays and Fridays. Open from 10 to 6. (2)
3. Kew Gardens and Museum	22,622	9,935	8,966	S	Open on Sundays and week days. (3)
4. South Kensington Museum	38,922	51,485	89,756	M	Open morning and evening till 10, on Mondays, Tuesdays, & Saturdays. Students' days—Wednesday, Thursday, & Friday, 6d. entrance. Open from 10 till Sunset.
5. Bethnal-green Museum	7,600	31,614	48,190	M	Ditto. (5)
6. National Portrait Gallery, South Kensington	2,000	..	..	M	Return refused. Open daily except Sundays. (6)
7. School of Mines and Mining Record Office, Geological Museum, Jermyn-street	8,997	3,969	4,436	M	Open daily, except Sundays and Fridays, and in the evenings till 10 of Monday, Tuesday, and Saturday. (7)
8. Patent Office Museum, South Kensington	..	13,818	24,513	M	Open daily, except Sundays. (8)
9. Edinburgh National Gallery	2,100	..	9,400	M	(9)
10. Edinburgh Museum of Antiquities	..	..	8,594	M	(10)
11. Edinburgh Museum of Science and Art	10,998	27,236	26,068	M	Open daily (10 a.m. to 4 p.m.) except Sundays, and Friday and Saturday evenings (6 to 9). Students' days—Monday, Tuesday, & Thursday; admission 6d.; other days, admission free. (11)
12. Edinburgh Botanic Gardens	1,750	2,081	1,259	M	(12)
13. Dublin Museum of Natural History	1,762	6,260	5,998	M	Open daily, & in the evening. (13)
14. Glasnevin Botanical Gardens and Museum	2,224	4,989	3,219	M	Open daily, including Sundays. (14)
15. National Gallery of Ireland	2,389	7,550	9,401	M	(15)
16. Museum of Royal Irish Academy, Dublin	300	..	..	M	(16)
17. Zoological Gardens, Dublin	500	3,003	2,720	M	Open daily, including Sundays. Number of visitors in July, 15,281. (17)
18. Tower of London	1,590	17,793	22,356	S	Open daily, except Sundays. (18)
19. Royal Naval College, including Greenwich Painted Hall	38,051	19,860	23,893	S	Open daily, including Sundays. (19)
20. Royal Naval Museum, Greenwich	1,055	2,223	3,762	S	Open daily, except Fridays and Saturdays. (20)
21. India Museum, South Kensington	..	1,228	2,113	M	Paid for by Indian Government. Open on Mondays, Tuesdays, Fridays, and Saturdays, 1d. admission; on Wednesday and Thursday, 6d. admission. (21)
22. Hampton Court Palace	7,475	2,424	2,976	..	Open on Sundays, and on week days except Fridays. (22)

(1) The numbers are those for the corresponding month of the previous year, as given in the Parliamentary Return.
(2) Open 19 days, from 10 o'clock to 4 o'clock, p.m., Thursday and Friday in Christmas week having been made open days to the public. Total of the year 1877 (11 months, or 190 days), 1,332,794. N.B.—These numbers do not include students nor other persons admitted on Thursdays and Fridays in the year.
(9) (10) Closed for November.
(11) Total number of visitors during year 1877, £372,585. Total since the opening of museum, 4,086,488.
(12) (15) (16) No information as to opening.

FABRICATION OF SOLUBLE GLASS AND SILICATE OF POTASH.

Twenty years since, Liebig suggested that the most rational material for the production of soluble glass was the *farine fossile.* M. F. Capitaine has recently taken up the subject, and has treated it in the pages of *Dingler's Polytechnische Journal.*

It appears that, with the exception of a small production of silicate of potash, the makers of soluble glass have not made any use, or very little, of this peculiar form of soluble silicic acid. The old methods are still in favour, the principal of these being two, one that which is employed in England, and the other that adopted on the Continent. In the English method the glass is produced by boiling silex in a caustic solution, while on the Continent the mode is, first, to make glass with sand, sulphate of soda and charcoal; afterwards, to render it soluble by means of the action of steam under high pressure. M. Capitaine does not think that the *farine* can compete in cheapness with flint when the latter is abundant, but then it has the advantage of being much more soluble.

Flint, broken up into pieces of about a cubic centimetre and submitted, under a pressure of steam of 4½ to 6 atmospheres, to the action of an alkaline lye of the density of 1·25 to 1·30, for six or eight hours, yields glass which is very alkaline and caustic, containing about one part of alkali to two parts of silica. With *farine fossile* a lye of 1·2 density and a pressure of three atmospheres are employed, and in three or four hours' process there is a yield of a much more neutral glass than the preceding, containing about three parts of silica to one part of alkali.

The production of silicate is said to be very easy with *farine fossile*, and M. Capitaine thinks that the causes which have prevented the *farine* being used instead of flint are purely accidental.

The *farine* is first calcined, an operation which takes a long time, because not a trace of the organic matters found in natural earths must be allowed to remain in the product; if this condition be not observed the solution obtained by means of the lye will have a yellowish or brownish tint, which will make it difficult of sale. The mineral is a bad conductor of heat, so that it does not calcine with facility. This inconvenience alone has perhaps caused the *farine* to be neglected by the makers of soluble glass on the score of economy. It is only within a short time that MM. Grüne and Hagermann have produced the calcined product at a relatively low price, and have thus afforded the opportunity of again raising the question whether the humid process with *farine fossile* is not really preferable to the employment of flint.

M. Capitaine, with this idea, undertook a series of experiments on a large scale. The lyes being prepared partly with caustic soda and partly with carbonate of soda, had densities ranging from 1·22 to 1·24, which were found to be the most advantageous. A reservoir, furnished with mechanical agitators, was about two-thirds filled with lye and the necessary quantity of calcined *farine* added, the stirring being kept up continually. The proportion of *farine* is easily calculated on the *datum* that one part of hydrate of soda dissolves about 2·8 parts of chemically pure *farine*, the quality of which varies but little. Lye of the density indicated produces a rather light solution which presents little resistance to the agitators. If steam is afterwards introduced, the solution becomes very rapid when the pressure reaches about three atmospheres, and at the end of about three hours the silica is completely dissolved. Practice soon shows when the operation is complete by the colour of the liquid, and by the fact that a sample taken out of the reservoir clarifies very rapidly. The colour of the foreign matters then in suspension is of a dark red brick. If an excess of *farine* has been employed, or the boiling has not been continued sufficiently long, the colour will be of a reddish white, and the solution will not clear itself when allowed to stand at rest. A small excess of silica left undissolved will cause the solution to remain turbid for a very long time, and it is extremely difficult to get rid of the excess by filtration. But this inconvenience is easily avoided by care in practice, and a uniform solution is obtained, which clears itself readily. One condition must, however, be always observed. If the lye be too concentrated, of a density of 1·3, for instance, the solution precipitates but very slowly the fine sand and oxide of iron which it holds in solution; a week is hardly sufficient for this to be completed. Too strong a lye should, therefore, not be employed; the density of the solution should not exceed 1·18.

If the silicate has a density exceeding 1·18, the best way is to reduce it by the addition of water; the clarification will proceed very quickly, and at the end of four-and-twenty hours the liquid will be perfectly white and clear. The deposit which is thrown down, composed of sand and oxide of iron, is rather more abundant than in the case of a solution of flint, but it is easily washed, and if mixed with diluted soluble glass, forms good glaze or dressing.

For the preparation of silicate of potash, which is to contain as strong a dose as possible of silica, for surgical purposes, the *farine fossile* is said to be peculiarly adapted. In this case the boiling must be continued for one or two hours longer than in the case of soluble glass, with an addition of 10 to 15 per. cent of *farine*; by these means a liquid is obtained rich in silica, which begins to congeal when its density is 1·32.

Farine fossile may also be employed in combination with flint. A glass is first produced from flint, which is afterwards converted into a neutral silicate by being well agitated with *farine* in a second vessel; or, a single apparatus may be made to suffice, by adding to the flint the necessary quantity of *farine.*

VINE AND FRUIT CULTURE IN SOUTH AUSTRALIA.

Vine culture is an important and progressive industry in South Australia. Mr. Boothby, the Government statist, in his report mentions that 5,050 acres of land are devoted to this purpose, the total number of vines being 5,155,988, of which 4,874,507 are in bearing. The produce of these vineyards, for the year ending March, 1875, was 648,186 gallons of wine, about 130 gallons per acre. The suitability of the soil and climate to the growth of vines was soon discovered by the early settlers, some of whom had brought from Europe a variety of high-class vine cuttings. The slopes of the hills produce wines of a full-bodied character, similar to those of Spain and Portugal, whilst those made in the more elevated districts resemble the lighter wines of the Rhine. Whilst the local demand is fully supplied at very cheap rates, a considerable export trade in wines of a higher character is carried on, and this might be increased to a great extent but for obstructive fiscal laws. Whilst the lower class wines of the Continent are admitted to the ports of the mother country at a minimum rate of duty, the customs dues charged upon superior wines from Australia are so high as to be almost prohibitory. To show that the wines of South Australia are, as a rule, of a high character, Mr. Boothby refers to the fact that they have always been awarded prizes at the several great international exhibitions.

Considerable attention has been paid to the manufacture of preserved fruits and the drying of raisins and currants. This branch of industry is rapidly progressing, and whilst it now goes far to supply local requirements, will probably soon develop into an export trade. Almond trees are of rapid growth, and large quantities of a superior description of soft-shell almond are gathered yearly for home consumption and for shipment.

South Australia possesses all the conditions requisite

for the successful and profitable culture of the olive. This tree, like the vine, was early introduced into the colony, and its growth and productiveness have been so remarkable that large plantations have been established and stocked with the best continental varieties. Olive oil of the most delicate character has been expressed, and gained awards at the various exhibitions. Its purity and general superiority over the imported articles of commerce has acquired for it a first position in the market. The produce of the plantations is eagerly purchased by persons who have entered upon the business of the manufacture of oil.

It is stated, as showing the importance which is attached to the cultivation of the olive, as of the mulberry (of which several plantations of the most suitable kinds exist for the development of sericiculture), the almond, vine, orange, fig, and hop, that the land laws provide that the planting and cultivation of one acre of land with any of these trees shall be equivalent to the cultivation of six acres of cereals.

Orchards, gardens, and vineyards abound, and in short, it is said, the variety and excellence of the fruits and vegetables produced in the colony cannot be surpassed. The climate and soil enables the productions of temperate and tropical regions to be cultivated almost side by side, and throughout the year, and offers an unlimited field of profitable occupation in connection with ordinary farming pursuits.

NOTES ON BOOKS.

Domestic Economy and Household Science. By R. J. Mann, M.D. London, 1878. E. Stanford.

The object of this manual appears to be throughout to give such information in elementary science as may prove useful for the purposes of daily life. It is intended mainly for advanced pupils and for teachers, but, as stated in the preface, it is meant for others also:—"There is, in reality, scarcely anything in its pages that does not need to be intelligently understood by men as well as by women." The range of the Domestic Economy requirements of the regulations of the Education Department is covered by the book, but the arrangement is different, and the subjects are not restricted to those enumerated in the Code. The first section is introductory, and gives an "Alphabet of the subject." It treats of the composition of air, water, &c., the "elements of living structures," and similar points. Section II. deals with "Food, Clothing, and Drink," and is divided into chapters, having for their subjects respectively, the "Nature and Action of Food," the "Classification of Food Substances," the "Preparation of Food," and the "Nature and Action of Drink." Section III. is concerned with "Heat, Clothing, and Washing." Section IV. is entitled "The Health, the House, and Money," and is subdivided into chapters on "Health and Disease," "The House and its Appliances," and "The Economy of Money." All the above chapters are divided into short "lessons," of which there are in all sixty in the book. Thus the chapter on "The House," &c., contains "lessons" on ventilation, water supply, house sewers and drains, beds, bedding, and furniture, kitchen utensils and earthenware, candles and lamps, gas, mistresses and servants.

The Construction of Roads and Streets. By D. Kinnear Clark. London, 1878. Crosby, Lockwood, and Co.

This work consists of two parts, the first of which is a revised and condensed edition of Law's "Art of Constructing Common Roads," and the second, which is entirely the work of Mr. Clark himself, treats of "Recent Practice in the Construction of Roads and Streets, including Pavements of Stone, Wood, and Asphalte." The whole is largely illustrated with woodcuts. The object of the writer has been to collect and put into compendious form, easy of reference, the information which has hitherto been scattered in periodicals, reports, and transactions of societies.

GENERAL NOTES.

Spelling Reform.—The Lord President of the Council has consented to receive deputations at the Education Department, Whitehall, on Friday, January 18th, at two p.m., from the London and numerous provincial School Boards, and from the Conference held at the rooms of the Society of Arts in May last. The object of the deputation is confined to requesting the appointment of a Royal Commission to inquire into the subject of English spelling, with a view to reforming it in the interest of education. Amongst the School Boards, of whom there are some 130 who concur in the request for a Royal Commission of Inquiry, are the following:—Liverpool, Birmingham, Bradford, Darlington, Keighley, Luton, Nottingham, Pembroke, Rochdale, Wolverhampton, Wednesbury, Brighton, Cardiff, Hull, Kidderminster, Maidstone, Ryde, Worcester, Wakefield, Aldershot, and Southampton. The deputation will assemble at the Education Department, at a quarter before two o'clock, on Friday, January 18th.

Industrial Exhibitions.—Exhibitions will, in all probability, shortly be supplemented by some of an entirely new class. In the interests of industry and commerce a plan has recently been devised for establishing great permanent depositories of patterns in large towns and cities. These establishments are intended to offer to the producers and consumers permanent centres of intercourse, for the purpose of affording visitors, especially importers and exporters, the means of informing themselves as to what is being done in connection with the industry and trade of the countries in whose manufactures they are interested, and in regard to all novelties produced. With this view there will be established shortly in Hamburg, and also in London, permanent exhibitions of the principal German articles of industry and commerce. In Vienna, likewise, a similar scheme has been projected for some time. The plan is looked upon with much favour in Germany. The exhibitions are to include patterns, designs, models, drawings, &c. Purchasers will have the benefit of being enabled to refer to the patterns of goods and manufactures, which are not only to form objects of exhibition, but likewise to serve as a basis for the transaction of business, and for judging as to the quality of the articles shown, as well as of their comparative value in competition with what is produced elsewhere.—*Trade Marks.*

NOTICES.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at eight o'clock. The following arrangements have been made:—

January 16.—"The Manufacture of India-rubber and its Application to Telegraph Purposes." By T. T. P. Bruce Warren, Esq. William Hawes, Esq., F.G.S., Deputy-Chairman of the Council, will preside.

January 23.—"The Art of Marbling." By C. W. Woolnough, Esq.

January 30.—"The Art Manufactures of Japan." By Christopher Dresser, Esq., Ph.D. Sir Rutherford Alcock, K.C.B., F.R.G.S., will preside.

February 6.—"Higher Commercial Education." By John Yeats, Esq., LL.D.

February 13.—"The Systems of Cremation in Use upon the Continent." By W. Eassie, Esq.

February 27.—"The Past, the Present, and the Future of the River Thames." By J. B. Redman, Esq.

March 6.—"On an Electric Lamp-lighting System." By St. George Lane Fox, Esq.

March 13.—"The Type-writer." By R. Brudenell Carter, Esq., Member of the Council of the Society.

March 20.—"Emery and Corundum Wheels for Grinding and Surfacing Metals and other Materials." By A. H. Bateman, Esq., F.C.S.

African Section.

Tuesday evenings, at eight o'clock. The following arrangements have been made:—

January 15.—"Notes Regarding the Zulu Kafirs, and the Probable Influence of the Transvaal Annexation upon the Progress of Civilisation in the Interior of Africa." By Frederick Bernard Fynney, Esq., of the Colonial Service of the Transvaal. (The meeting changed from January 22 on account of Mr. Fynney's earlier embarkation for the Transvaal.) Admiral Sir Erasmus Ommanney, C.B., F.R.S., will preside.

February 19.—"Egyptian Obelisks and their Relation to Chronology and Art." By Basil H. Cooper, Esq., B.A.

Indian Section.

Friday evenings at eight o'clock. The following arrangements have been made:—

February 1.—"The Destruction of Life in India by Wild Animals." By Sir Joseph Fayrer, M.D., K.C.S.I.

February 22.—"Irrigation Regarded as a Preventive of Indian Famine." By W. T. Thornton, Esq., C.B.

Chemical Section.

Thursday evening at eight o'clock, The following arrangements have been made:—

February 14.—"Recent Improvements in the Metallurgy of Nickel," by A. H. Allen, Esq., F.C.S.

February 28.—"The Chemistry of Infection, or the Germ Theory of Disease from a Chemical point of View," by C. T. Kingzett, Esq., F.C.S.

Cantor Lectures.

Monday Evenings, at Eight o'clock. First Course, on "The Manufacture of Paper," Six Lectures by William Arnot, Esq., F.C.S.

Lecture V.—January 14th.

The Chemicals used in the paper mill; their nature, economical use, and methods of valuation. The recovery and re-use of soda as an economical process and in its sanitary bearings. The disposal of washing and machine waters, so as to minimise the pollution of streams.

Lecture VI.—January 21st.

The various classes of Paper; characteristic differences. The determination of the ash or loading. Water supply. General arrangement and construction of the mill.

MEETINGS FOR THE ENSUING WEEK.

Mon.....**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. William Arnot, "The Manufacture of Paper." (Lecture V.)
Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Resumed Discussion on Mr. T. C. Smith-Woolley's paper on "Warping."
Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. 1. Mr. H. Seebohm, "His recent Journey io the Yenisei and Oh." 2. Mr. F. B. Fynney, "The Geographical and Economic Features of the Transvaal."
Medical, 11, Chandos-street, W., 8.30 p.m.
London Institution, Finsbury-circus, E.C., 5 p.m. Dr. B. W. Richardson, "Health and Education."
Social Science Association, 1, Adam-street, Adelphi, W.C., 8 p.m. Mr. Lewis Angell, "London Water Supply."

Tues. ..**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr. Frederick Bernard Fynney, "Notes Regarding the Zulu Kafirs, and the Prohable Influence of the Transvaal Annexation upon the Progress of Civilisation in the Interior of Africa."
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m., The President's Inaugural Address.
Statistical, Somerset-house-terrace, Strand, W.C., 7¾ p.m. Mr Robert Giffen, "Recent Accumulations of Capital in the United Kingdom."
Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.
Biblical Archæology, 33, Bloomsbury-street, W.C., 8½ p.m.
British Horological Institute, Northampton-square, E.C., 7.30 p.m. Mr. E. J. Watherston, "Political Economy, with special reference to the Taxation of Gold and Silver Plate."
Zoological, 11, Hanover-square, W., 8½ p.m. 1. Mr. F. Moore, "A Revision of the Genera and Species of European and Asiatic *Lithosiidæ*." 2. Mr. A. Boucard, "List of the Birds Collected in Costa Rica." 3. Mr. G. French Angas, "Descriptions of Seven New Species of Land Shells recently collected in Costa Rica hy Mr A. Boucard." 4. Mr. G. French Angas, "Description of a New Species of *Latiaxis*."

Wed.... **SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr. T. T. P. Bruce Warren, "The Manufacture of India-rubher and its Application to Telegraph Purposes."
Meteorological, 25, Great George-street, S.W., 7 p.m. Annual General Meeting. Address by the President.
Entomological, 11, Chandos-street, W., 7 p.m. Annual Meeting.
Archæological Institution, 32, Sackville-street, W., 8 p.m. 1. Mr. H. Syer Cuming, "Misletoe." 2. Mr Thomas Morgan, "The Relics Brought from Hissarlik by Dr. Schliemann, now in South Kensington Museum."

Thur.... British Horological Institute, Northampton-square, E.C., 7.30 p.m. Half-yearly General Meeting.
Royal, Burlington House, W., 8½ p.m.
Antiquaries, Burlington House, W., 8½ p.m.
Linnean, Burlington House, W., 8 p.m. 1. Prof. Owen, "*Hypsiprymnodon*, a Genus indicative of a distinct Family in the Diprotodont section of the Marsupialia." 2. Mr. Francis Darwin, "The Nutrition of *Drosera rotundifolia*." 3. Prof. St. G. Mivart, "Notes touching recent Researches on the Radiolaria."
Chemical, Burlington House, W., 8 p.m. 1. Dr. Frankland and Mr. Thorne, "The Intrinsic Luminosity of Benzole." 2. Mr. F. Jones, "On the action of Reducing Agents on Potassium Permanganate." 3. Dr. Wright and Mr. Luff, "The Alkaloids of the Aconite Family. The Alkaloids of *Aconitum ferax*." (Part II.) 4. Mr. Spencer Pickering, "The Action of Sulphuric Acid on Copper." 5. Dr. Ramsay and Mr. Dobbie, "The Decomposition Products of Quinine."
London Institution, Finsbury-circus, E.C., 7 p.m. Mr. H. Morley, "English Novelists of the Nineteenth Century." (Lecture II.)
Society for the Encouragement of the Fine Arts, 9, Conduit-street, W., 8 p.m. The first *Conversazione*, at the Galleries of the Society of British Artists, Suffolk-street, Pall-mall East.
Numismatic, 4, St. Martin's-place, W.C., 7 p.m.
Royal Society Club, Willis's Rooms, St. James's, S.W., 6 p.m.

Fri.......Philological, University College, W.C., 8 p.m. 1. Mr. Hy. Nicol, "Middle English Orthography." 2. "English Derivations."

Sat.......Working Men's Club and Institute Union (at the House of the Society of Arts), 4 p.m. Lecture by Dr. Stroughton.
Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Mr. W. H. Preece, "Some Physical Points connected with the Telephone." 2. Mr. H. F. Morley, "Grove's Gas Battery."

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,313. Vol. XXVI.

FRIDAY, JANUARY 18, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

INSTITUTIONS.

The following Institution has been received into union since the last announcement:—

Brighton and Hove School of Science and Art.

AFRICAN SECTION.

Tuesday, January 15th; Admiral Sir Erasmus Ommanney, C.B., F.R.S., in the chair.

The Chairman, in opening the meeting, said:—Upon the occasion of our resuming the course of meetings in this Section for the ensuing session, the friends of Africa cannot fail to entertain the highest sense of satisfaction at the material progress which has been made in advancing our knowledge of the condition of a very large extent of previously unknown territories in that continent. Within the brief space of three years, and since Sir Bartle Frere inaugurated the opening of this African Section by his excellent address, what important discoveries have been achieved! We have indeed had placed before us in that time almost all that we can desire to know regarding the physical features of the interior of South Tropical Africa. Bearing in mind the object which this Society has in view, that, namely, of opening up the interior of the African Continent for the encouragement of trade and civilisation, it is a cause for deep interest and thanksgiving to have received from those heroic travellers, Stanley and Cameron, such valuable reports regarding the regions which they have traversed with such indomitable courage. We learn that these vast territories are fertile, and that they possess a climate favourable to the European constitution; the interior is intersected by rivers and lakes, that afford an almost continuous water communication between the Indian and Atlantic oceans. When reflecting upon the state of this continent, the mind is perplexed at the mysterious dispensations of Providence, as well as at the indifference of the civilised world, which have, up to this period, kept concealed such a large surface of our planet, containing productive lands, but inhabited by human races that are still in the most debased conditions of barbarism; for it is hardly possible to doubt that the same amount of enterprise, enduring courage, and expense, which has been so advantageously and patriotically devoted to explore the Arctic regions during three centuries would, if employed in this direction, have brought to light the deplorable condition of the African races ages ago. It is almost vexatious to have to think how small an Imperial grant would serve to complete the thorough examination of the Congo. It is nearly four centuries since the American continents were opened to the enterprise of the European nations; only behold what a change has been accomplished there! Surely we may confidently look forward to a similar future for Africa, when this continent is once fairly open to receive the colonist, the merchant, the missionary, and philanthropist, whose work and privilege it is to civilise and introduce the habits of useful industry and trade, aided as these influences are now in this generation by scientific appliances and thoughtful organisation. Rejoicing in the triumphant achievement which has placed Stanley in the van of the noble explorers who have traversed Africa, with which all have become familiar through the reports given in the *Daily Telegraph* and other journals, we may now congratulate ourselves at length in having before us a clear conception of the physical features of the interior of this great continent, and of its natural products, soil, and climate; sufficient information, indeed, is now secured to enable us to commence in earnest with the work of civilisation and commercial enterprise. This illustrious traveller had already covered himself with glory in his exploration around the shores of the Victoria Nyanza, and the country intervening between that lake and the Tanganyika. Unmindful of the trial or fatigue, and with almost superhuman endurance of privation consequent on the three years' trial amongst the savages of Equatorial Africa, Stanley, with undaunted courage, resolved upon yet further attempts to explore the Congo, proceeding to Nyangwé, the point where Cameron was frustrated by hostile tribes, and having an able second in Pocock, whose life has been sacrificed in the cause, and also a party of followers strong enough to protect him in his adventurous course, he launched himself upon the Lualaba, which proved to be, as Cameron had already anticipated, the chief tributary of the Congo. Overcoming marvellous obstacles, fighting his way through the opposition of sanguinary savages and cannibal tribes, and surmounting formidable cataracts, he has navigated through to the Atlantic this mighty river, the mysterious Congo, whose volume surpasses the Nile, establishing the fact of a continuous water communication through the continent of 1,200 miles, and encountering in some parts of the newly-discovered tract peaceful, well-disposed natives, dwelling in fertile countries. In a few days this heroic adventurer will land upon our shores, and we are not without hope that we may be privileged to welcome him here at some early meeting of this Society, and hear from his own lips an account of the countries which he has discovered. With regard to the work which the enlightened advocates of progress have now to prosecute, and which this Society has so much at heart, not only the civilisation, but, as one would also aspire to forecast, the colonisation of tropical and central Africa, there are some considerations which it is necessary to keep in mind. The negro race is spread over these regions, and that constitutes one of the features of the difficult problem which has to be worked out. For myself, I feel confident that, owing to the mental inferiority of this race, they are incapable of rising to any better state of existence, or of shaking off their savage customs, unless under the domination and through the guidance of the white man; and I think that Cameron has put forth a good practical suggestion as to the best measures in order to attain a footing in these regions, in recommending the establishment of stations to serve as bases for thorough exploration, and for bringing the natives under orderly subjection. In this direction we already have promise of excellent results, from the influence of the International Congress, so auspiciously inaugurated by H.M. the King of the Belgians, which has proposed a Commission for the exploration and civilisation of Africa, and has invited all nations to bear their part in the promotion of this object. France, Germany, Austria, Hungary, Italy, each with its separate expedition, are

to be engaged in penetrating unknown regions under the patronage of crowned heads and princes, including our illustrious President, his Royal Highness the Prince of Wales. Even Portugal has been aroused to its sense of duty—a country which has never turned to advantage the valuable means that it has possessed through its colonies of opening up the interior or benefitting the natives. The Portuguese Government has now granted £20,000 towards starting off various exploring expeditions. In this country several independent agencies are already doing real and practical work, the most prominent among them being those noble pioneers, the missionary societies, of whose doings we shall happily hear more on future occasions. Without entering more in detail into that theme now, it is nevertheless well to say that the party sent out by the Church Missionary Society reached the shores of Victoria Nyanza in January last, and have established there a station, and have obtained the good will of a native potentate who seems to appreciate the blessings of Christianity. Another important step of incalculable benefit, accomplished also by this society, has been the construction of a waggon track for a distance of 250 miles from the East Coast to Mpwapwa; on the borders of the healthy upland district, waggons have gone over this track in six days, journeying towards Lake Tanganyika. On the southern shore of Lake Nyassa, the Free Church of Scotland has planted the station Livingstonia, which may be considered as permanently established witb beneficial results. The suppression of the slave trade still requires a continuance of the humane and vigilant efforts in which our navy has been steadily and patiently employed. Those only who have been actually engaged in this service can possibly comprehend the trials and privations which our cruisers have to contend with on the East and West Coasts of Africa; I regret to state that the slave trade on the East Coast is still actively carried on, as I find from the reports of my nephew, commanding a cruiser on that station, that he has been singularly successful in capturing several slave cargoes. The main question that concerns the immediate progress and advancement of civilisation in Africa is that of the sinews of improvement, as well as of war—money. As yet the response from the public to the appeal from the Exploration Fund Committee of the Royal Geographical Society has produced only £2,000. This nation stands foremost in the world as the great civiliser of the barbarous sections of the human race; we must therefore hope that this sanguinary war in the East may speedily come to some peaceful conclusion, and that the public interest may be again turned with greater force towards the amelioration of Africa. There is now ample evidence that Central Africa abounds in the natural requisites for producing food supplies in any quantity; and with this assurance there can be no doubt that capital may be discreetly and judiciously employed in this region so as to make an adequate return. The region which forms the subject of the first communication this Session is one that possesses strong claims upon public attention and interest just at this time, on account of its quite recent annexation to the British dominions. It is a matter of general notoriety that this annexation by the Government of Great Britain has been made solely and entirely in the interest of civilisation and peace. A series of altogether undesired events have forced this extension of her African possessions upon England, to avoid the alternative of a fierce outburst of war between the Dutch colonists and the native tribes. The south-eastern frontier of the Transvaal State is the boundary also of the territory of the Zulu Kafir race; the most powerful, and warlike, and at the same time most organised, and ably led, of all the native tribes. Disputes have already arisen between the Dutch settlers and the Zulu chief, in reference to lands along the frontier line, and a somewhat grave hostile collision has actually occurred between a subordinate chief, bound by allegiance to the Zulu ruler and the Dutch, which threatened to light up a widely extended resistance on the part of the natives, who are in any way connected with, or influenced by, the Zulus. In this serious emergency, her Majesty's Secretary of State for the Colonies judiciously appointed Sir Theophilus Shepstone, late and long Secretary of State for native affairs in Natal, a gentleman who is familiar with every turn of the native mind, and with every incident of contemporaneous native history, to take the Transvaal under his charge. The opportunity to do this was substantially furnished by the two facts—first, that the Dutch settlers were originally British subjects, having emigrated from the British possessions constituting the Cape Colony, and were allowed to settle their own government upon the condition that they would establish a strong, a considerate, and a prosperous State; and secondly, that these conditions had not been fulfilled, and that in the presence of the danger which had, consequently, ensued, a large and influential part of the inhabitants of the Transvaal are actuated by a strong desire to be under the guidance and protection of the British policy and government. Still, the real cause for the assumption of the government of the Transvaal State—and this must be distinctly understood —is the unavoidable conviction that, by this step alone, a fierce war on the immediate confines of British territory, and almost sure to involve our own relations with the belligerent tribes, could be avoided. In the settlement of these difficulties, and in the organisation of the government of the newly annexed territory, which are now in progress, the Zulu Kafir race, and the remarkable chief who is the supreme and paramount ruler of this race, will, assuredly, play a prominent part. Mr. Fynney, the gentleman who contributes the paper this evening, has been present in the Transvaal, and upon Sir Theophilus Shepstone's staff, during the proceedings which have led to the annexation of the territory, and has, I believe, been employed in negociations with the Zulus, which have brought him into personal relations with their chief, and which have enabled him to glean much information regarding these people which cannot fail, in the present contingency, to be both of interest and of great practical value. It is of these things that he has kindly consented to speak. But as he is constrained to embark for the resumption of his official work in South Africa before the evening which was originally fixed for the opening meeting of the African Section, it has been considered advisable to secure the opportunity of his own presence at the Section by holding the first meeting at a somewhat earlier date than was, in the first instance, intended. It is this arrangement which has afforded me the pleasure that I now enjoy of presenting Mr. Fynney to your consideration.

The Paper read was—

NOTES REGARDING THE ZULU KAFIRS, AND THE PROBABLE INFLUENCE OF THE TRANSVAAL ANNEXATION UPON THE PROGRESS OF CIVILISATION IN THE INTERIOR OF AFRICA.

By Frederick Bernard Fynney.
Of the Colonial Service in Natal.

It will be in the memory of the members who interest themselves in the business of this African Section of the Society of Arts, that a valuable paper was communicated by Mr. (now Sir) Theophilus Shepstone, at the opening meeting of the Session in 1875, and that some additional remarks were made by Dr. Mann, upon the early history of the Zulu Kafir race. Since that time, a series of events have occurred, which have given increased force and power to some of the circumstances then named. As I have, during that period,

been in intimate personal communication with these people, and am now, after a brief holiday, about to resume my official work upon the immediate threshold of their land, it has occurred to me, as an introduction to what I desire to say, in response to the invitation which I have received from the committee of the Section, to give some account of the state of affairs in and around the Transvaal territory, to offer some account of my own personal impressions regarding the remarkable man, who at this present time holds their destiny in his hands, and who will assuredly play a not important part in the changes which are in immediate progress.

In the papers to which I have alluded, it is especially insisted upon that, up to the close of the last century, anything like serious warfare was unknown amongst the Kafir tribes of South-Eastern Africa, and that tribal quarrels were a farce, so to speak, and lasted but a day. In those times, the word Zulu was almost unused, and certainly did not bear the terrible significance which it subsequently acquired.

Two separate chieftains, Punga and Mageba, are somewhat loosely spoken of as having been the founders of the then small tribe, and as ruling over it conjointly. The first authentic and exact information we possess concerning it dates only from the time of Senzangakona, who ruled the Zulus at the close of last century.

You have already been told in the paper to which I have referred, that a son of this chief, named Utyaka, or Chaka, fled with his mother, Unandi, to his relative Dingiswayo, the "Wanderer." She was obliged to do this to save her own life, as well as that of her unruly son, whose pride and arrogance had rendered him obnoxious to his father.

Dingiswayo "toláď," or picked up, Unandi and her son, and showed great kindness to both her and the lad. Utyaka repaid this kindness by fighting the battles of his adopted chief as a bold warrior, and by a friendship and fidelity which were life-long.

I have often listened by the camp fire with the deepest interest to tales of old grey-bearded warriors of the Umtetwa tribe, of which Dingiswayo was the chief, as with flashing eyes and animated countenances they fought over again well-known battles, in which Utyaka, their companion and afterwards king, took more than his share of danger, and when I have reminded them of his cruelties, they have answered, "Utyaka hated a coward, but was always the brave man's friend."

But to return to Dingiswayo. He had learned something of civilised warfare during his long stay in the Cape Colony, but being of a mild and unwarlike disposition, it remained for Utyaka to develop and apply the knowledge which was imparted to him by Dingiswayo. Utyaka remained with Dingiswayo some 18 years, at the end of which period his father, Senzangakona, died. Utyaka was then established by Dingiswayo as chief of the Zulus. This new position, though greatly in advance of that which he had occupied for the past few years, did not, however, satisfy his pride and ambition, the Zulus being really a comparatively insignificant tribe, or, as the natives put it, "a small house." Utyaka, therefore, at once commenced a system of aggression against the immediately surrounding tribes, subduing one after another until he was recognised as conqueror by a very considerable following.

Up to this time the native tribes carried on warfare, so to speak, by a kind of personal conflict, each man fighting as he liked, and where he liked. For this purpose each warrior provided himself with a number of assegais, which were used as javelins, and furnished with a long shaft; the combatants never approaching closer than fifty yards. Utyaka benefiting, by the information he had received from his patron Dingiswayo, and grasping at once the weak points of this mode of warfare, enrolled his warriors into regiments, appointing officers of different ranks over them, similar to our colonels, captains, and lieutenants, and armed each man with a single assegai (the handle or shaft cut short) and a shield. At his first battle his orders were, "Let the enemy throw while you look on; when they have finished their spears then rush in and stab; they will be like cows before you."

Not only did Utyaka institute this new kind of warfare, but he also proved himself to be an able general, personally taking command of his army, superintending and directing its movements from some eminence near by, and having his eye, not only on every regiment, but upon each individual warrior. As he stood surrounded by his aide-de-camps and a chosen body-guard, if he saw a warrior turn from the fight he immediately had him brought up to him. He would inquire what he was afraid of, and upon receiving the reply that "ngityewe uvalo" (his heart had given way), Utyaka would order some of his guards to prod him with assegais as a punishment for cowardice; or should he notice one of the regiments give way, it would be sent for, and on arrival, disarmed, and then butchered by some braver regiment. Thus his warriors were forced to be brave, for, as they said, "Where does not death meet us?"

The dread of this new mode of combined attack, and the invincible courage of Utyaka's warriors, spread on every hand, resulting in the dispersion or subjugation of every tribe against which he fought. As they submitted to him he enrolled the young men of each tribe amongst his regiments, and so, like Cæsar and Alexander of old, with an increasing territory he had an increased and stronger army.

While thus augmenting his dominion and personal power, Utyaka continued a loyal and true friend to his paramount chief, Dingiswayo, but on Dingiswayo's death, Utyaka absorbed the Umtetwas by force of arms.

I may here advantageously add a word or two concerning a few of those tribes which, not being subdued by Utyaka, were dispersed *en masse* before him. Umzwilikaze fought Utyaka the whole day until sunset, but during the night, fearing the issue of another battle, retreated with all his people, and, fighting his way through different tribes, eventually settled near what is now the capital of the Transvaal—Pretoria. He continued to occupy this locality till driven away by Dingaan, the successor of Utyaka, when he located himself in what is now known as the Matabili country, north of the Limpopo. Ungeto, Undwandwe, and Undhlela fled with their tribes to the south, passing through what is now Natal, and settled ultimately in British Kaffraria. Umalusi, a

powerful chief of the Xumalo tribe, retired towards the north, crossed the Limpopo, and occupied the country between that river and the Zambezi, along the eastern slopes of the watershed. Others again crossed the Zambesi, spreading themselves north of that river and on the banks of the Shire. It hence happens that we find a Zulu speaking people from the Great Fish river, in British Kaffraria, to the very centre of Africa.

Utyaka having thus raised the insignificant tribe of Zulus into a great nation, and being the undisputed sovereign of all South-Eastern Africa, died at his chief kraal, "Kwa'Dukuza," on the 23rd day of September, 1828, by the hands of assasins, who were, indeed, his own brothers, Dingaan and Umhlangana. The Zulu army was at this time at the Ubalula or Oliphant's River, in the Transvaal, and Dingaan seized the opportunity of getting himself recognised as king, conjointly with Umhlangana. Before the return of the army, however, Dingaan assassinated Umhlangana, and thus remained in sole possession of the Zulu throne.

Before passing on to the particulars of Dingaan's reign, it occurs to me to mark a few of the personal characteristics of the great Utyaka. He was, undoubtedly, an able and successful general, and a good administrator. His will was strong and uncompromising, and his courage unquestionable. He was essentially a proud and ambitious man, yet his sensibilities were exceedingly keen. On the one hand he never forgave an injury, and on the other, he never forgot a kindness. When he came into power he caused a whole kraal to be killed off, because they had refused him milk when he was a boy. The instances of his enduring memory for kindness evinced to him are very numerous. When king, he never rested till he had found out, and in some way or other rewarded, those who had shown consideration either to his mother or himself, and his uncorruptible fealty to Dingiswayo is, perhaps, the most memorable proof of this fact. Yet, with all this, Utyaka was at the bottom a hard-hearted and cruel savage. In his early life he determined never to allow a child of his own to live as a future competitor for power, and for many years his will in this particular was regarded; but, as she grew old, his mother longed to have a grandchild to caress, and, by stratagem, upon one occasion endeavoured to give effect to her wish. Unfortunately, Utyaka broke into her presence without notice, having received some hints as to the real state of the case, and found his mother fondling the child. With his own hands, this Lion of Zulu-land, and conqueror of South-Eastern Africa, stabbed to the heart the mother who had gone through so much danger for his sake, and who had preserved his life at the risk of her own. This is an extreme case, in its terrific and repulsive character, but it is far from being the only instance of the fierce despot's cruelty that has remained in traditional story.

Utyaka was always deeply impressed with the power of the English nation, of whom he had heard Dingiswayo speak; and so important did he deem their friendship that he sent two of his chiefs, Sotobe and another, to Cape Town, "to offer his hand," as he said, to that people.

I must now pass on to a few references to Dingaan. There are no particulars of much moment to be spoken of in regard to him till the Boers, under Retief, came into Natal, in the year 1838, to found, as they hoped, a republic, where they might be free from the many restraints imposed upon them by the British Government, under which they had lived in the Cape Colony.

The Boers found this land of promise destitute, almost, of inhabitants, as Utyaka had, with his bloodthirsty bands, carried desolation throughout it; but, unoccupied as it was, it was claimed by Dingaan, who refused Retief's application to be allowed to settle in it with his followers, excepting on one condition. That condition was, that Retief should attack a chief named Sigonyela, who had seceded from Utyaka, and who, in the possession of horses and guns was considered too powerful for the Zulu warriors—he had formed a tribe on the south-western parts of Natal. Retief was to take all the cattle he could from Sigonyela and hand them over to Dingaan as the price of the country asked for. The bait took, Sigonyela was attacked by Retief, his people slaughtered, and large numbers of cattle taken. These were delivered to Dingaan by Piet Retief (who was accompanied by 70 picked men from the emigrant Boers, together with 30 young Hottentots) at his head kraal in Zulu-land, Umgugundhlovu, on the 2nd day of February, 1838. The king (who had treacherously arranged his plan of action) professed to be highly satisfied with the way in which Retief had carried out his part of the bargain, and collecting several of his regiments, prepared, as he said, to do kingly honour to his friends and guests. War dances and sham fights were gone through, and all went merrily as the marriage bells. At last the document which was a cession of the whole of Natal to the Boers was duly executed by Dingaan and his principal chief, and Retief having accomplished the object of his visit, prepared to leave. His crafty host, however, desired him, with his followers, to enter the royal kraal once more for a parting cup, also requesting that all arms should be left outside as they were not foes but friends. This was done, pots of beer (utyalwa) were passed round, and some of the king's picked regiments were ordered to form a circle and entertain his guests by a war dance, composed for the occasion. At a signal from Dingaan, "Bulalani Abatakati," or "kill the witches," the warriors closed around the helpless Boers, and, after a brief struggle, cut them off to a man, throwing their bodies in one great heap outside the royal kraal, where their remains were found some months afterwards by Pretorius and his commando. As soon as this awful tragedy had been enacted, Dingaan at once gathered his army, and sent them, as he thought, to exterminate the few Boer families who had remained with the wagons in Natal. Whilst the emigrant Boers were there anxiously watching for the return of their comrades from Zulu-land, they were startled from their slumbers by the war cry of thousands of Dingaan's warriors, who had crept up to the encampment during the silent watches of the night, and great numbers of men, women, and children were butchered before any resistance could be made. Neither space nor time allow me to narrate, as it should be told, this dreadful story. Suffice it to

say that even the women fought with desperation against overwhelming odds, while many a mother's heart was wrung by seeing her child dashed to pieces against the wagon wheels. So great was the slaughter, so deep the anguish and grief, that the place was called "Weenen"—or weeping—and as such is known to this day. To make the matter fully clear, it will be necessary, however, to explain that the emigrant Boers who were left behind were scattered in bands in different parts of the country of Natal, and that the camp at "Weenen" was only one of several.

Upon hearing the sad news, the Boers of the other camps determined to punish Dingaan, and mustering 800 strong, marched against him, but were defeated with much loss. Soon afterwards a man, famous amongst his fellows, Andries Pretorius by name, collected another command of 600 men, and advanced into Zululand. They were met at the "Income"—Blood River (so called from the number of Zulus slain)—by ten thousand of Dingaan's boldest warriors, who, on a Sabbath morning, at the end of the year 1838, charged up to the hastily-formed laager (or defence of the Boers), with their short spears, hurling regiment after regiment at it, only to have their ranks thinned by the fire from the encampment. The brave Boers, at last reversing the order of things, became the assailants. The Zulus were then shot down by thousands. Victory remained with the Boers, and the power of the treacherous Dingaan was broken for ever. As the Boers lost no time in following up their victory, Dingaan was obliged to fly, and, with a few followers, was killed at the foot of the Bombo mountains, by a band of Amaswazi. The Boers found the body of Retief on the heap of their slain comrades, with the treaty, uninjured, in a leather bag by his side. These facts I give as I have heard them often from warriors who took part in the different events. Many a thrilling narrative could be told of Dingaan's reign, did space permit. Time, however, intimates that this may not be done, and all that is is now necessary is to pass on, and say something of his successor Umpande, more commonly known as Panda, who was the fourth son of Senzangakona, the other three being, as already indicated, Utyaka, Dingaan, and Umhlangana.

When Dingaan killed Utyaka and Umhlangana, he also wished to put an end to his brother, Umpande, but as this man had for years feigned stupidity, and was looked upon by the chief as little better than an idiot, they dissuaded Dingaan, saying "Why should the king kill fools;" and though Dingaan replied that he was sparing a dog which would some day bite his legs, still Umpande was spared, and had the charge of some of the royal cattle given to him, being considered unfit for anything connected either with war or council. He was called the royal fool. Panda played his game long and well, and when the Boers fought the Zulus at the Income, Umpande fled from Zulu-land with some followers, and placed himself under the protection of the Boers, taking part with them in the last conflicts.

Dingaan, like Utyaka, having died without leaving any children, Umpande was proclaimed by the Boers as king of the Zulu nation. This occurred in the year 1840. He at once made a treaty of peace with the Boers, ceding to them all right to Natal, and for thirty years ruled his people well, kept faith with both the Boers and British Government. was always a true friend to both, and died peacefully in his royal kraal, Nodwengu, in 1871. Umpande only made war twice during his life time, once against Sigwata Sicocoenis, father, and on another occasion, against the Amaswazi. He was a man of peace, and dearly loved a joke. He proved himself also wise by listening to the council of the British Government, and by opening his country to the missionaries, whom he often invited to preach before him at his royal kraal; always showing the kindliest feeling, and paying marked attention. He was the steady friend of the missionary. Unlike his brothers, Utyaka and Dingaan, Umpande had a large family, and his elder sons unfortunately embittered the late years of the king, by constant quarrels as to who should succeed him. Two of them, Umbulazi and Cetyweyo, at length determined to decide the issue by fighting during the king's life time. This the king himself rather encouraged, to end, no doubt, what was to him a constant trouble. Accordingly the two brothers assembled their partisans, to the number of many thousands, and fought one of the most sanguinary battles ever known in that part of Africa, close upon the north-eastern boundary of Natal. Some seven thousand of the combatants were killed. This battle resulted in the death of Umbulazi, leaving Cetyweyo as the unresisted claimant to the succession. This event occurred in the year 1854.

For some years before the king's death, Cetyweyo acted as regent. After that event, and in 1872, he was formally crowned as king, by Sir Theophilus Shepstone, acting for the Natal Government. On that memorable occasion a code of laws were given to him for the government of his people, which he agreed faithfully to carry out, professing his desire always to be considered as a child of her Most Gracious Majesty the Queen of England.

Cetyweyo is a man of noble presence, a very king among his people; his height is about 6 ft.; he is broad, well made, though very stout, and really handsome. He has a small, keen, bright eye, deeply fringed with thick, regular, and long lashes. His nose is small, and his forehead high, and he has a beautifully cut chin and mouth. In fact, I can but characterise his features as classical, quite different from the generally accepted idea of the Kafir race. The first time I saw him after his accession as king, it seemed impossible to me that such a benign and intelligent countenance could be owned by one of whom so many cruel and heartrending tales had been told, but during our conversation a topic was touched which instantaneously caused that countenance to change. Then, and not till then, did I fully realise that the spirit of Utyaka was inherited by Cetyweyo.

Cetyweyo is an altogether irresponsible despot; his word is law, and the least disobedience, or supposed disregard of that word, in most cases costs the life of the offender. Life is held at the lowest possible rate. Cetyweyo himself says, that a Zulu will not pay attention unless he has a good warning, and killing is the best of all warnings that can be given. He is very superstitious, a great believer in witchcraft and evil agencies, and hundreds of his sub-

jects are sacrificed every year on this account. Like the rest of his people, Cetywcyo is an uncompromising Conservative; all he wants from the white man are guns, ammunition, and blankets. Both he and his leading chiefs are entirely averse to mission work in his land, and he has made it a crime, punishable with death, for any Zulu to become a Christian, for Cetyweyo holds that a Zulu converted is a Zulu spoiled, and that each mission station is a centre of disaffection in the land. No one knows better than he does that the Zulus would crowd to the mission stations by hundreds if allowed.

Cetyweyo is unquestionably a man of great intelligence. Like his uncle Utyaka, he has devoted a great deal of attention to raising and perfecting his army. Of late years he has armed many of his different regiments with guns, and taken a deal of pains in teaching his warriors their use. He has a large number of military kraals, and the warriors belonging to each kraal are obliged to attend for a great part of the year, as their duty to the king is considered to be a paramount one; in fact, by many punishments, the king has taught them that it is. I am not in a position to give anything like a reliable estimate respecting the numerical strength of the Zulu nation. It is a very difficult matter to get at this, and mere guesswork is better left alone. All that can be said is that Zulu-land extends from 26° 34″ to 29° 14″ South Latitude, from 30° 40″ to 32° 50″ East Longitude, and that it is in many parts thickly populated. The fighting men are generally spoken of as from 40,000 to 60,000.

The upper parts of Zulu-land are particularly suitable for stock. Sheep, and all horned cattle thrive excellently, and every part is fertile. The most picturesque regions are what may be characterised as the middle parts. I feel it would be impossible for me to convey to you an idea of the beauty of this portion of Zulu-land. It must be seen to be appreciated. Upper Zulu-land is divided from the lower by a mountain range, the Inhlazatye and Untabankula being the highest points. The part which is known as middle Zulul-and is the country directly to the east of the mountain range. The climate is delightful, and highly suitable to the European constitution. Lower Zulu-land has a beauty of its own, it is covered to a greater extent with bush. The fertility of the land is also remarkable, being suitable for the growth of sugar, coffee, tobacco, arrowroot, and all tropical and semi-tropical produce. It is well watered throughout. Zulu-land is divided from Natal by the River Tugela on the lower part, and by the Umzinyati, or Buffalo, on the upper. There is not the slightest doubt that the country is rich in minerals. I have myself found samples of gold there within a few hours ride of the Tugela, but owing to the great prejudice the king entertains against prospecting of any kind, and the strict orders he has given to his people to watch closely all white people going about the country, it is impossible to make anything like a reliable survey or examination.

The Zulus, as a people, are powerful, well built, and capable of great endurance. They are bold and warlike: in fact, every Zulu male looks upon himself as born a kingsman and warrior, and his greatest ambition is to fight the foes of his country, or, perhaps, it should be rather said, to make raids and eat up cattle. They are all very superstitious, believing in witchcraft and the influence of good and bad spirits. They are greatly influenced by a class known as "abangoma," or smellers-out of witches. These people are really the priests of the land. They profess to be in league with the spirits, and able to divine; and are held in great respect, and consulted in cases of sickness, or of "imihlola," *i.e.*, anything of ill-omen happening. At these consultations certain incantations are gone through, and a "smelling-out" follows, as all sickness and ill-fortune is ascribed to evil influences by some one of their own community. Although, theoretically, a Zulu will admit that there is such a thing as death from natural causes; still, practically, there is no belief in anything of the kind. If any one asks what So-and-So died of, the answer invariably is, "We do not yet know, as we have not been to "Bula" —or to consult the diviners. Of course, at these consultations some one must be "smelled out" as the evildoer, and the result too often is his death. An "umtakati," or witch, never finds a friend. Thousands, and tens of thousands, have been slain simply on the word of these "abangoma." Instances have come under my own observation, in which large kraals, containing dozens of men, women, and children, have been destroyed at a moment's notice for some fancied evil influence worked by one of their occupants.

I have said the Zulus are a fine race physically; I am proud to be able to bear testimony to some other high qualities which they also possess. Zulus are truthful as a rule; they are honest, unrevengeful, and faithful to a degree. I have spent 27 years amongst them, travelled thousands of miles with none but Zulus to attend me, and have, for long periods at a time, had to depend upon them alone for my safety. I have suffered from fevers far away from the aid of any of my own race, and for days have been tenderly cared for by them, and should have died had it not been for that care. All this, too, when it would have been quite easy to have put an end to me, and to have appropriated what to them was a mine of wealth, viz., my guns and ammunition. Yet in all this time I never, to my knowledge, lost the value of a shilling.

The Zulu is naturally idle; he scorns work, and spends his time either hunting, singing, dancing, smoking, drinking beer ("Utywala"), or speaking soft words to some young Zulu belle, whom it must, nevertheless, be years before he can claim as his own, for the king never allows his warriors to marry till they are well advanced in years. Then whole regiments are married off at once.

The Zulu women do all the work. They cultivate the ground, aid in building the kraals, bring wood, carry water, prepare the food, in fact, attend to everything, and so far from feeling these duties a burden, they go about cheerfully, quite contented with their lot, and what is very wonderful, they manage to agree amongst themselves pretty well, though perhaps 20 or more in the same kraal may own the sway of one liege lord. A certain number of cattle are paid for each wife, and a ceremony gone through, which is binding. Such a thing as infidelity, I may say, is almost, if not entirely, unknown, being punishable by death. The women are exceedingly graceful and good-

looking while young, but age fast, and in many cases have a haggard look after a few years of the toil entailed upon them by married life.

Cattle are the principal riches of Zulu-land, as amongst the other tribes of Africa, and a man's wealth is estimated according to the number of cattle, sheep, and goats he owns, in fact, cattle are the £ s. d. of the Zulus. During the reign of Utyaka, Dingaan, and Umpande, cattle were very plentiful, and the country was extremely rich in vast herds, but the lung sickness and redwater (diseases which have sprung up of late years) have made great ravages. The king, too, has parted with many thousands in the purchase of guns, so that now the country is poor in stock compared with what it was. In olden times, if cattle were required, a raid was made upon some of the weaker tribes, the people slaughtered, and their stock taken; not so now, thanks to the restraining influence of a wise and strong Government. Cetyweyo dare not raid; and let us hope that the fangs of the Lion of Zulu-land are in process of being drawn for ever, and that the day is not far distant when the influences of civilisation and Christianity shall light up all the dark corners of this beautiful country; when a Zulu shall understand that there is something more worth living for than the shedding of blood; when superstition and error shall no longer claim its thousands of victims; when hymns of praise shall supersede the old war cry, and fields of ripening grain cover ground once stained by human slaughter; and when the missionaries, those servants of God, who have sown the precious seed often in tears and deep despondency, shall return from their exile to reap their harvest with joy and gladness.

There are great numbers of this very race in Natal, who, having taken refuge there, have thrown off their old customs, and adopted, not only the faith of the white man, but the usages of civilisation. And though we may be obliged to admit, with regret, some instances of failure in our efforts for the improvement of this interesting people, we may also point to many notable proofs of success, and to none with more satisfaction and pride, than to that which is involved in the fact that, however threatening and powerful the barbarous despot may be who is just coming out into prominent notice, in our relations with the independent Zulus, there is already a strong and large native power, drawn from the very same source, which is ranged on the side of order and peace, and which is sheltered, in Natal, under British rule. It is hardly too much to say that the native population of Natal, who have most of them the same blood in their veins, are fast approaching in numbers the dark hordes of the neighbouring Zulu-land, and if they are less powerful for purposes of war then their kindred who still remain under the bonds of the savage despotism, it is only so on account of the good lessons they have learned at our hands. The authority of Cetywayo, supreme and irresistable as it is, is based so entirely on terror, that if at any time he came into collision with the power of England, and met with a signal reverse, he would, in all probability, be swept away like a reed, by the prompt insurrection of his own people, as has been the state of all his ancestors before him.

It is a notorious fact that the still recent annexation of the large territory, known under the designation of the Transvaal State, by the British Government, has been virtually brought about by the dangerous relations existing between the Dutch settlers there and the native tribes of the district. When Natal, after a brief conflict with the emigrant Boers, was settled as a British colony, in 1843, a large number of the Dutch withdrew towards the North, and crossed the Vaal branch of the Orange River. Finding no very strong opposition from the native tribes there, they took possession of the land, and this formed the *quasi*-civilised occupation of the Transvaal. In the year 1848, these Dutch occupants of the Transvaal joined their kindred in the Free State on the south side of the Vaal River, in an attempt to resist the establishment of British authority on that side of the Vaal, and were beaten in the battle of Boomplatz. At the commencement of the year 1852, a treaty was made between the emigrant settlers in the Transvaal and the British Government, in which it was stipulated that the settlers should be allowed to form a republic and govern themselves in the Transvaal. But it was an important part of the provisions of this treaty that the emigrant farmers should not practise slavery in any form in their new State, and inferentially, therefore, that the British Government reserved to itself the right to insist upon fair and merciful treatment for the aboriginal inhabitants of the land. The Dutch Boers were substantially in the position of a body of subjects of the British Crown, to whom the privilege of managing their own affairs was conceded under certain qualifying conditions.

The Boers in the Transvaal, immediately after the conclusion of this treaty, proceeded to settle their State after their own fashion. They elected a president, and drew up a constitution upon paper, which they called their State laws, one of which was the "Fundamental Law." The very spirit and essence of this law was the remarkable declaration that they "did not admit equality of persons of colour with white inhabitants either in State or Church." With such a resolution as the base of their first attempt to create the organisation of a new State, it can hardly be matter of surprise that their failure has been so signal as it has proved.

Under their first president, the farmers of the Transvaal were in frequent hostile collision with the native tribes around. In the year 1854, the Boer Hermanus Potgieter was murdered by a chief whilst engaged upon a hunting expedition, and in revenge a tribe, amounting to some hundreds of individuals, was almost exterminated in a cave in which they had taken refuge. At a more recent date the Transvaal Boers entered upon a dispute with the Zulu potentate, Cetywayo, who then laid claim to the districts of Wakkêrstroom and Utrecht, which are on the southern slope of the Drakenberg Mountains, but which had been occupied by the Boers. The president, nearly at the same time, claimed territory beyond the south-western frontier of the State, which properly belonged to the Griqua chief, Waterboer, and which included, as will be remembered, the newly discovered diamond fields situated towards the confluence of the Hart and Vaal rivers. In 1872, Mr. Burgers became President of the Transvaal, and although a more enlightened and able man than his predecessors,

proved quite unable to change the behaviour of the Dutch colonists towards the natives. Hostilities then broke out with Secocoeni, a chief residing within the disputed district of the south-east, which were unsuccessfully and blunderingly prosecuted by the Boers, and which threatened to bring the Zulus into the field, as Secocoeni was in some measure a feudatory of Cetywayo. It was under the events which arose out of this complication that Sir Theophilus Shepstone was sent into the State, to endeavour to arrange some safe plan of compromise with the Boers; or, failing to accomplish that, to assume the control of the territory, upon the ground that the Dutch settlers had not fulfilled the condition upon which their independence had been recognised. It is a matter of familiar knowledge that the latter alternative is the one which has had to be acted upon, and that the Zulu territorial claims have now to be settled with the British Government, under circumstances which will leave no doubt as to the spirit in which the arrangement will be made.

The Transvaal territory which has thus been added to the British possessions in South Africa, is about the same size as England, Wales, Scotland, and Ireland, taken together. It is a mixed mountain and pastoral region, with uplands between 4,000 and 7,000 feet above the sea, with a fine climate, sunny and dry in the winter, but with abundant rains through the season of greatest heat. The district of Zoutpansberg lies fairly within the tropic of Capricorn. The uplands afford excellent pasture for horned cattle, horses, and sheep throughout the year, and cereal crops can be very advantageously grown in the winter under a system of irrigation.

But the most important point of view in which the British annexation of this territory has to be looked at is, unquestionably, the guarantee which it gives of the speedy introduction of civilisation into the very heart of this inland range of the great continent. It changes, as if by the stroke of the magician's wand, throughout this vast territory, the "Fundamental Law," which admits of no equality between white people and black, for that other great canon which recognises no distinction in the claims of an universal brotherhood, and of a common humanity. The failure of the Portuguese, as colonists, along the coast of both sides of the continent, is due to the circumstance that they have hugged the sea. They have simply occupied narrow and isolated trading stations, through which they have introduced quite as much evil as good for the native races, and they have established, virtually, no influence over the native habits or mind. The English, on the other hand, and super-eminently the Dutch, have gone boldly into the land, and occupied the ground with their own habits of life, and their own ideas of social organisation and progress, and in this way have established an example and a power which no barbarism can long withstand. Unfortunately, however, those grand old pioneers, the Dutch farmers, with their brave hearts and strong hands, have been paralysed as civilisers, by the taint of practising domestic slavery. But, as in the case of the Transvaal, they have continually occupied and broken fresh ground, into which the spirit of a holier and gentler civilisation is sure soon to pour, and in this way they have done good work, which should never be forgotten when accounts are squared, and which, it is not too much to say, never have been forgotten wherever the British Government has taken upon itself the responsibility of rule. The large amount of fine land still held by the Dutch Boers within Natal is incontrovertible evidence of this, as is also the still more pregnant fact, that the most advanced and enlightened of the Transvaal Boers have desired the annexation by Great Britain as the best possible event that can happen for their interests. In his proclamation announcing the annexation of the State, her Majesty's Commissioner affirmed that a large proportion of the inhabitants of the Transvaal had expressed, in the clearest and most unqualified form, their desire for the establishment of the British rule.

But the most casual glance at the map shows what the civilised and industrial occupation of this beautiful tract implies. The land itself rests upon an impregnable and established base, the long-occupied and well-settled districts of the Cape Colony and Natal, and it projects northwards up into the heart of the barbarian fastnesses of the great continent. It reaches to the confines of Mosilikatse's inland and upland kingdom on the north, and it cuts off the Bechuana barbarism on the west from the Kafir savagedom on the east.

The northernmost point of its frontier also, it will be perceived, is within about 270 miles of the Victoria Falls of the Zambesi, the last upward obstruction of the great stream, whose stretches from that point consequently constitute themselves, with their widely radiating affluents, a grand water highway for transport and commerce, quite up to the central watershed of the heart of the continent, where the primary sources of the Congo and Zambesi interlace, and where the traders from the east coast encounter the Portuguese traders from the west.

Not the least of the beneficial objects which it secures is the remarkable way in which it completely hems in, and surrounds, the Zulu-land itself, the last stronghold of barbarian life in this part of Africa; for the Amatonga race which dwells between the Lubombo mountain frontier of the Transvaal and the sea, is formed of a docile people, with none of the fierce and cruel traditions of the Zulus. With a strong and orderly government established in the Transvaal, the successors at least of the present ruler of Zulu-land will have to furnish very strong guarantees for their good behaviour, and will have to change their habits of life in some very important particulars, which, with a larger opportunity at my command, I should have been glad to dwell somewhat further upon, and which, at some not very remote date, I shall hope to say something further about, for on returning, as I am just about to do, to this advanced ground of African civilisation, I shall cherish the hope of being able to send to the African Section of this useful Society accounts of realisation and progress which will amply justify the views I have ventured to express in these, perhaps, too hurried remarks, for which the brief period of my visit to England may possibly be allowed to be my excuse.

DISCUSSION.

The Chairman having invited discussion upon the paper,

Dr. Mann said—The subject which has been brought under the notice of the meeting by Mr. Fynney is of exceeding importance just at this time, on account of the very recent annexation of the district by the British Government, and the influence which this step exerts not only upon the fortunes and prospects of the district itself, but also upon the well-being of much larger territories lying immediately beyond and around, and to which the annexed district itself is the natural portal. The remarks made concerning the native tribes, and especially concerning the character and temper of the remarkable savage who, at this time, sways the destinies of Zulu-land, are of especial interest, because it so happens that Mr. Fynney is intimately acquainted with the language, the traditions, and the modes of thought of the Zulu tribes, having enjoyed exceptionally good opportunities for personal intercourse with them, and being somewhat an intimate acquaintance, if he will allow me to say so, of the noble Cetywayo himself. There is no doubt he could tell us many more notable things concerning that despot than he has ventured to relate, if he were not in some degree restricted by the delicate relations of the present time. The plain fact regarding the history of this remarkable man is, no doubt, that he is waiting upon events. He is a person of very considerable ability, and of very large ambition. He possesses a great influence amongst neighbouring tribes, so long as his star appears to be in the ascendant. He is keenly alive to the altogether invincible power of England. He is far too shrewd and observing a man not to be thoroughly conscious of that. But it is surely not to be looked upon as an impossible event that a noble savage should "drift into war," when that operation seems to be one which the more civilised and self-controlled potentates of the day are not altogether able to avoid. The two elements of danger, in that point of view, are first, that Cetywayo is the chief of the young blood; his prestige amongst his own people mainly rests upon his reputation amongst the hot-headed young warriors of the tribe, who are not as keen calculators of the cost of glory and war as the chief is himself. And secondly, the arming of the native tribes with guns, which is one of the items of the dark side of the account, that stands against the discovery of the diamond fields. There is a general tendency in the native mind to look upon the gun as the secret of the white man's power, and, therefore, too hastily to rush to the conclusion that when a black man acquires a gun a revolution has been secured in the chances of any armed conflict. This belief Cetywayo, no doubt, shares to a considerable extent, and it is not yet possible to say how far the belief may prove to be strong enough to tempt him on to the edge of the precipice that lies before him. The real weakness of this otherwise dangerous man is that his rule is based on cruelty and terror. He entered into a compact with the Natal Government on his accession to old Panda's seat, to rule with justice and mercy. That compact, it is not too much to say, has not been observed. I believe it is pretty well known that the gun is now largely used as an engine of personal rule in the interior arrangements of Zulu-land, where the knobkerry and the assegai did duty in the olden time. The consequence of this relation with his own people is that at the first turn of fortune against his supremacy he will disappear from the scene. Chaka and Dingaan both suffered shipwreck upon that rock. Both were assassinated by their own people when the fortune of war was against them. Umpande, the only Zulu chief within the century who was peaceful and merciful in his rule, is the only one who has survived to a natural termination of his life after a long reign. It is also perhaps a circumstance affording some ground of anxiety at the present time, that there is really heroism enough in the character of this ambitious and subtle man to make him, in some circumstances, quite capable of facing the risk of a violent but glorious death, in preference to losing ca te amongst his followers. The Transvaal, which has been brought into such prominent notice by recent events, is a wonderful land, and well deserves the auspicious fate which we may hope is in store for it, under the circumstance of its transference to British occupation and rule. It is so varied a land that there is scarcely anything which may not be done in it with proper selection of spot, and with intelligent and skilful management. Of the thirteen provinces into which it is divided by the accidents of its earlier history, Pretoria, the district in which the capital and the seat of government is placed, is, upon the whole, the most central province, and stretches toward the north part up to the 25th parallel of south latitude, which is roughly taken as the line that limits the tropical climate. It is in the main an upland district with much good pasture land, and with tracts suitable for grain crops at the base of the Magaliesberg Mountains, which traverse its centre. It is a fine cattle country, and is occupied by prosperous and wealthy Boers. One of them, Harry Struben, has recently built himself a residence at the cost of £2,600. The land in this district is rising rapidly in value; a farm adjoining the township of Pretoria was but a few days ago sold at public auction for £7,250. Potchefstroom, which lies to the south-west of Pretoria, is also in the upland territory, but slopes away to the Vaal river, where it has a long river frontier, traversed by numerous drifts, or fords, and conferring upon it the advantage of an intimate connection with the Orange river sovereignty, which stretches beyond the river to the south. It is reckoned a good pastoral and agricultural district, and is, perhaps, upon the whole, the best occupied province of the Transvaal. It is already doing a large trade in corn with the diamonds fields of Griqualand West, from which it is within quite a manageable distance. The Marico province, and some part of the adjoining province of Rustenburg—which are commonly esteemed the garden of the Transvaal—form the western side of the State, looking towards Bechuanaland and the vast inland plains. Wheat, oats, barley, maize; tobacco, coffee, sugar; the vine, the orange, and forest trees are all said to find suitable haunts, and to be capable of remunerative cultivation, in these provinces. The Waterberg and Zoutpansberg provinces lie along the broad loop of the Limpopo river in the far north, and are chiefly composed of comparatively low bush covered land, infested by the *tsetse* fly, which is so deadly to cattle, and breeding fever in many parts. They are, therefore, the most desolate and least occupied tracts of the territory. Zoutpansberg itself was a thriving settlement of the Dutch pioneers some years ago, its prosperity having then been mainly due to ivory, ostrich feathers, and other produce of the chase. It was deserted in the first instance in consequence of troubles with the natives. It has an almost tropical climate, and a very fertile soil, with large stretches of valuable timber. It is said that the Boers of the province in early days had large flocks of thriving sheep, notwithstanding the heat. Farms of 600,000 acres in extent have been offered for sale in the hot Waterberg region, within the last four years, for £25. The general rise of the price of land throughout the Transvaal is, of course, producing its effect upon this district, as well as the rest, and there are, no doubt, stretches of fine land contained within the province. But the question has yet to be settled what such land can be made to do under the circumstances in which it is placed. It is certainly unsuitable for horses and sheep, and has a very nearly tropical climate, that is trying to Europeans from temperate lands. The eastern side of the Transvaal is primarily interesting on account of its mineral wealth. The Drakenberg range of mountains, which form the seaward frontier of Natal, here run quite within the territory of the Transvaal, to constitute the province of Lydenberg by both slopes, a lower and parallel range distinguished as the Libombo mountains, there forming the eastward

frontier towards the Amatonga and Gasa land and the sea. The main Drakenberg range expands laterally in the Zoutpansberg Province to the north, and there looks down upon the valley of the Limpopo as from a broad terminal buttress, constituting the Murchison range in its highest parts, and the Zoutpansberg lower down. On the southern extremity of the Lydenberg county, the famous New Scotland district is placed. It consists, I believe, of about 640,000 acres of excellent land, affording splendid winter pasturage, especially for horned cattle, and is well watered, and abundantly supplied with timber. Land in this district sells for from 2s. to 3s. an acre. The Province of Wakkerstroom lies still further to the south, and enjoys the advantage of touching, in one part, the frontier of Natal. It comes within 30 miles of the township of Newcastle. It is chiefly formed by the westward slopes and spurs of the Drakenberg mountains, which here enter the Transvaal, and is consequently an eminently upland district, suited for sheep, cattle, and horses. It is esteemed as one of the best stock countries in the Transvaal, and its land accordingly fetches high prices. It is already one of the wealthiest provinces. The eastward slopes of the same stretch of the Drakenberg constitute the Utrecht division of the Transvaal, the part of which became the bone of contention between the Boers and the natives, and which is still claimed by Cetywayo. This region has been for some time kept back by the troubled relations with the natives, but it is a capable and promising land. A very intelligent friend, of great judgment and experience, recently writing to me from the Transvaal from this spot, says "The Zulus now all possess guns, and the young men continue to be clamorous for war, even although they will have to fight the English. When we do fight it can only end in the complete demoralisation of the Zulus, and the breaking up of their tribe. Personally, if I had to begin again, purchase land, and settle as a farmer, I would, notwithstanding the fact I have named, prefer Utrecht to all other spots. The land is cheap there, it joins the Natal land of Newcastle, and it is the nearest part to the Natal port." It is one notable peculiarity of the Transvaal that in consequence of having its rainy season in the summer, the period of scarcity of food and of cold go together. This has a very important bearing upon its characteristics and capabilities, both as a pastoral and agricultural land. Nature has obviously intended here that the superabundance so bountifully bestowed in one season shall he garnered in to eke out the deficiencies of the opposite time. The expedient adopted by the Boers was to cheat nature, and turn the flank of the difficulty, by "trecking" from the high veldt to the low in the season of scarcity. Every farmer has his winter farm as well as his summer pasture. This expedient, however, is only possible so long as the land has a scanty population. What is now wanted is that feeding and agriculture shall go hand in hand, and that both shall be carried out with intelligent forethought and care. When farming is conducted upon this plan, and provision is artificially made for the dearth of the winter, the hills and slopes of the Transvaal will easily be able to support a full million of white settlers. The same friend to whom I have already alluded, recently remarked to me in writing of this peculiarity, "the men of the Transvaal as much need mowing machines, as the women want sewing machines." One great reason for the fertility of many parts of the Transvaal is that the goodness is not washed out of it, as it is in some of the lower regions, like Natal, by the greater copiousnes of the rains, and the steep slope of the water shed. The Transvaal is essentially a place with a very gentle fall for its rivers. The latest estimate I have seen of the population of the Transvaal gives 48,000 for the number of the white settlers, and from a million to a million and a half for the natives within, and immediately around the frontier. The territory itself covers, I believe, about 72,000,000 acres. There are 12,000 farms, presumed to be about 6,000 acres each in extent, registered, as held by proprietors, in the Government office. Intending possessors of land should, as a matter of course, take care in any case to know what the character of land is before they buy. For this reason, leasehold occupation, with agreed upon and secured right of purchase, is obviously the prudent course to adopt in acquiring land. In all cases purchasers should also well bear in mind that it is in the nature of things that a non-occupation tax will, before long, be one of the sources of public revenue in the Transvaal. I remember to have heard that all the farms which were granted before 1865, and which bear this original date upon the titles, were good land; and that farms with more recent titles are, in a large number of instances, of a less desirable character. In all countries situated as the Transvaal is, live stock are prone to special diseases and drawbacks. This remark applies with the greatest force to horses and sheep. In the Transvaal these animals require, not only well-selected stations, but good and locally-acquired management. Lung sickness also attacks the horned cattle. At one time, before its ravages commenced, the Transvaal was pretty well the grazing ground for the entire Cape Colony. It has recently been estimated that the native population of the Transvaal, under a good system of management, should yield a revenue to the State of some £80,000 a year, and be themselves infinitely the better and more prosperous for the impost. The cereal crops in the Transvaal are sown in the autumn, and cut in the spring. As the winter is invariably dry, this necessitates irrigation upon a somewhat large scale. There are extensive districts in which it can be efficiently applied, but corn grown under irrigation cannot compete with corn grown without. This is one of the difficulties with which the Transvaal has had to contead. With the present prices of labour, I am told it does not pay the farmer to sell wheat upon his farm at 7s. a bushel. The wages of the native farm labourers are from 15s. to 20s. a month, with rations. It is notorious that some considerable portion of the debt of the Transvaal has been contracted in the effort to establish a railway communication from Delagoa Bay to the Lydenberg frontier. There are, however, some grave considerations in connection with that scheme, which go far to bring compensation for its early collapse. In the first place the line would have to commence at a Portuguese port, and to pass for 40 miles through Portuguese territory; after that it would traverse a low, fever-haunted tract and another 100 miles of Amaswazi territory; and then a second hundred miles of wild and almost unpeopled land, before it abutted at last upon a bold mountain frontier. It would thus have to run with a dead weight of 240 miles upon it. On the other hand, when the Natal Railway, now in process of commencement, has once reached Newcastle, it will find an easy entrance there into the long gentle valley of the Vaal River, with a natural line laid out for it through the heart of the Transvaal to the Diamond Fields, and to the old colony districts beyond, every mile of which would, in all probability, pay and bring its own rapid increase. The mineral wealth of the Transvaal is one of its most promising and hopeful features. Coal stretches over the whole upper portion of the feeders of the Vaal River. It crops out along the eastern slopes of the Drakenberg, in the neighbourhood of New Scotland, on the head waters of the Usutu and Assegai Rivers, at the Eloi Mountain, and in the hills near Utrecht; and it also extends along the Vaal River to within 36 mlies of Potchefstroom. An estimate that I have seen, from an eminently reliable source, gives 16,000 square miles as the probable extent of the coal-bearing strata, with a deduction from that of 2,000 square miles for an intrusion of igneous rocks that has burst through the field in one locality. Iron has already been spoken of by Mr. Fynney. It is an abundant mineral in many localities. A rich red and malleable hæmatite is found in large quantity in the Marabastadt and Rustenburg districts. The red hæmatite exists in many places close to the

coal. I especially remember a description I once received from my old friend Mr. Percy Whitehead, of having ridden over a bed of rich magnetic iron ore, which extended for 20 miles. In that district every rivulet revealed deep beds of the valuable mineral, and hills of it were scattered along the plain. Copper is abundant alike in Pretoria, Rustenburg, and Lydenberg. The Kafirs have worked lodes of it in various places, before the advent of white men, to get ornaments for their women. I have heard of instances in which old workings of this character, 1,000 yards long and 40 feet deep, have been seen. The lodes all run east and west. It is fully anticipated that these old workings indicate still valuable deposits lower down than the rude mining of the natives. Lead also is seen in old Kafir workings, and is found in two rich veins near to Pretoria. A lead mine is also worked in Marico by Mr. Gray, which furnishes considerable quantities of the metal for local use, and which is said to be very rich and of inexhaustible extent. Mines of cobalt have been worked with considerable success during the past three years by a company known as the South African Republic Mining Company. One of the best authorities upon matters connected with the mineral products of the Transvaal is my old friend Mr. Percy Whitehead, who is connected with this company. It is from this gentleman that I have derived, from time to time, much of the information about the Transvaal that I possess. His present address is Pretoria, in the Transvaal; and I am not saying too much for him when I state that he is at all times ready to give information about the mineral characteristics and capabilities of the land. Gold has been now found in the Transvaal in several places. But the most promising of the gold fields are in Lydenburg, on the eastern slopes of the Drakenberg mountains. This range enters the Transvaal at the northernmost corner of Natal, close to the head waters of the Vaal River, and then runs through the midst of the Wakkerstroom and Lydenberg divisions up to the Murchison and Zoutpansberg ranges in the north. From the west, or inland side, the mountains are comparatively easy of access; but on the eastern or seaward side they descend precipitously 3,000 feet. On this face the mountains are cut into deep gorges and ravines by the torrents, and are clothed with masses of foliage. At the distance of 20 miles from the summit of the range the country falls again by a second step, and on the lower ledge beneath this step the four districts, known as Pilgrim's Rest, Mac-a-Mac, Spitzkop, and Waterfall, are situated. Pilgrim's Rest and Mac-a-Mac stand on either side of a low range of hills. Spitzkop is 18 miles to the south of this central region, and Waterfall 20 miles from it to the opposite direction, that is, towards the north. Rich patches of alluvial gold have been discovered in these fields in various places, and veins of auriferous quartz penetrate downwards and outwards in various directions. It is calculated that there can scarcely be less than 800 square miles of land, in which indications of gold have been seen. Notwithstanding the unsettled and precarious state of the relations with the native tribes, which have necessarily exercised a very embarrassing and repressive influence upon mining enterprise in this direction, numerous water-races have been estabished at considerable cost; in one instance the outlay having been as much as £1,100, and in another instance, £700. In another case machinery has been established for crushing at a floating reef at an outlay of £2,000. A return recently made gave £120,000 for the well-ascertained yield of the region up to that time, and £30,000 as the estimate of the value which had been privately carried away without any formal return. One claim was known to have furnished 96 ounces within two days, and nuggets of 20 lbs. weight had been amongst the richest prizes. There were about 500 miners at that time at work in the field, and the friend from whom this information came states that, exclusive of native labourers, the average yield per man, for one year, amounted to no less considerable a sum than £300. On account of the uncertain circumstances of the time, and the unsettled condition of the place, the cost of living was also extravagantly large, scarcely amounting to less than £10 per month for each individual. Gold reefs have also been struck at Ersteling and Marabastadt at the west end of the Murchison range, in the Zoutpansberg district, but no practical steps have been yet taken to test their value. These reefs run in an east and west direction, and crop out on the eastern slopes of the Drakenberg, especially towards the lead-waters of the Salate River. It is also said that a gold reef has been found between Pretoria and Potchefstroom. In alluding to the various instances of old metal workings scattered so abundantly about in the Transvaal some time ago, my friend, Mr. Whitehead, who is really a very excellent authority in this matter, insisted very strongly upon the well known fact, that many of the best mines of metal in Cornwall and in Germany, were superficially worked by the Romans in olden days, and that it is these early superficial and rude workings that have drawn attention to the wealth that has since been wrested from the deeper recesses of the earth by the employment of the better appliances that science now supplies. Enough will have been said, in the communications which have been placed before the Society to-night, amply to establish the great value and interest of the tract of land which has been thrown by the incontrollable force of events under the ægis of our Queen, in order that peace and orderly rule may be established upon its pastures and hills, in the place of oppression and discord. The difficulties of the position have by no means been yet finally overcome, although they have been honestly and bravely met. Her Majesty's Commissioner has the rash and impetuous savage to deal with at his doors, and a considerable party of the recusant Boers who still cling to the traditions of earlier days within the threshold. It is generally held, however, that these recalcitrant children of the Transvaal wilderness are an inferior race to their kinsmen in the Orange River sovereignty, and in the settled districts of the Cape, on account of their long sojourn in connection only with savage and barbarous tribes, which it must be admitted is not, in itself, altogether the best influenee to which men can be exposed. There are three circumstances, however, which are already at work, sapping the opposition of these sturdy men, and which may be safely left to accomplish the good work of conversion which they have begun. In the first place they have a very keen sense of the value of the enlarged market, higher prices, and more abundant gold which the English occupation brings. But besides this they are quite able to estimate at its full worth, the guarantee of peace and protection which a strong Government conducted upon English principles affords; and, over and above this, they are also rapidly making the discovery that an upright and even-handed administration of justice in the courts is more to be esteemed than some of the privileges which have clung closely round the old "Fundamental Law" of the republic. The conversion which is initiated by these subtle arguments will assuredly be carried to its proper end in the case of the children, by the power of advanced enlightenment and improved education. It would not be an easy task to characterise with adequate appreciation the temper and tact, the cautious judgment, and the shrewd common sense with which the special Commissioner who has had the work of annexation to accomplish in the Transvaal has dealt with the early difficulties of his enterprise. The entire community of Europeans in South Africa is, however, pretty well aware that it owes a heavy debt of gratitude to her Majesty's Principal Secretary of State for the Colonies, for the consideration and courage, and for the unhesitating promptness, with which he has met the early threatenings of the South African storm; and there is, perhaps, no other point in this matter for which a greater meed of gratitude is due to Lord Carnarvon than his judicious and happy selection of a gentleman, to carry

out his peaceful and protective policy, so thoroughly trained, by a lifelong and unintermitted service on the spot, to deal with the particular circumstances of the case. Sir Theophilus Shepstone is as familiar with the languages of both the Boers and the Zulus as he is with his own tongue. I am not sure that I ought not to say more so, for again and again I have heard him remark that he finds it more easy to' make a public address in the Zulu tongue than in the Queen's English. It will be at once perceived what an advantage this confers, because it enables him to get at the thoughts and inner life of the people that he has to influence and control. I may also, perhaps, be permitted here to say that I think Sir Theophilus himself has been fortunate, amidst the embarrassing financial elements with which he will have to deal, in having had the cordial and ready asssistance, upon his staff, of a gentleman who was for many years a colleague of my own, as chairman of a Bank of which I was a Director, and who is, I am prepared upon my own personal knowledge to say, as eminently fitted to deal with those questions as any authority who could have been found within her Majesty's dominions. I allude to Mr. Joseph Henderson, for many years a well-known and leading colonist in Natal. For myself I deem it a very happy augury for the future fortunes of the Transvaal that these gentlemen have chanced to be associated together in finding a practical channel through the quicksands and shoals amongst which the new dependency of the Transvaal has had to be launched. In the embarrassing question of finance, the position is also further strengthened by the presence of Mr. Sargeaunt, one of Crown agents for the colonies, and a gentleman who has had a very large experience, both in his official position in England, and at an earlier time in South Africa itself. Mr. Sargeaunt has been sent out as a special Commissioner to the Transvaal, by the provident care of Lord Carnarvon, to give his assistance in this particular branch.

Col. Crossman said the short time he had been in South Africa would hardly allow him to speak of the general treatment of the native races, or as to what the annexation of the Transvaal would do for the civilisation of South Africa. Having been in Kimberley for some time, in an official capacity, and having seen a great many natives who had come down to the diamond fields, a few remarks from him might be of interest to the meeting, particularly as those natives came from the country about the Transvaal, and, as they all agreed that the annexation of that country would have a great effect on all the natives who might come down to the diamond fields. When he was there three years ago there were some 8,000 or 10,000 natives working there. They were of all tribes, Basutos and others, from the western country, and even Zulus from the far east, coming down in droves of 50 or 100, generally under the supervision of some European, who had brought them down. He had himself seen them put up to public auction at Kimberly. No doubt they looked very like slave auctions, but that was the only mode in which native labour could be obtained at that time, and, indeed, it was not so illegitimate as might be imagined, because, being under the supervision of Europeans in that way, they came down to the gold fields under much better auspices than if they had been simply by themselves, and exposed to the tender mercies of the Boers. When he was there, a Commissioner was sent to consider whether that might not be done under Government agency, and though he had no knowledge of the steps that had been taken, he imagined that what ought to be done would be to establish depots, to which these men might be brought to be housed and fed on their way down, and again cared for when they went back to their own country. At that time difficulties existed which had now been removed, as the country had been brought under British protection; but formerly the people of the Orange Free State would not allow armed men to pass through their country, and very properly so, for there could be no doubt that every man who left the diamond fields had the fixed idea of returning with guns and ammunition, which were never intended for hunting, but for the purposes of war—war too, not with their own people, but with the white man. And it must be remarked that these men were not contented with the bad guns sent out from Birmingham, but were determined to have good weapons, and he had known the men to constantly examine the locks and sights and try the pieces before purchasing. They would insist on having good guns, "because," they would say, "the soldiers have good guns now, and we must have them also, for (and this was only two years ago) the fruit is not quite ripe yet, but it soon will be." There could be no doubt that the Kafirs had been preparing for the war which had just broken out. He was glad to see by the newspapers of to-day that Sir Bartle Frere had proposed a disarmament of the natives —a very difficult thing to carry out—and it would surely have been much better if the natives had never been allowed to become armed. It might be suggested that if they were to cease selling guns to the natives, the Kafirs would never come down at all, but, as they had heard to-night from Mr. Fynney, the Kafir had other things to think about and to buy besides guns and ammunition; he not only required cattle, but he also wanted to get money enough to purchase two or three wives more, so that in his old age he might have other people to work for him, and not be reduced to the necessity of working for himself. The treatment of, and the conduct shown towards the natives coming down to the diamond fields, must have a great effect upon the people of the interior, and it must be admitted that coming into even those rough settlements they were, on the whole, very well treated indeed. In a community like the diamond and gold fields of the Transvaal, as elsewhere, there was always a very large proportion of what might be called the rowdy element to be found, but, fortunately for South Africa, those districts were so far from the coast, and so difficult of access to people without means, that the condition of these particular diamond fields would compare favourably with that of many places much nearer home. On the whole, it could not be disputed that the natives at the diamond fields were very fairly, judiciously, and even liberally treated, and the fat, plump, well-conditioned Kafirs returning from the gold fields could not be recognised as the same miserable emaciated creatures who had come in, perhaps, only three or four months before. But, with regard to the question of civilisation, although their physical qualities were very much improved by their journey, it was to be doubted whether their morality was equally so, for in Kimberley, a very small place indeed, there were upwards of 130 licensed public houses, to which these had full leave and license to go, and their morals were by no means improved in consequence. Drink, disease, and crime were, it was to be feared, the results of their visits, to a very great extent. The great crime in that place was diamond stealing, and illicit diamond dealing; and he had seen there on Sunday afternoons a "swell nigger," may be a Christian, and certainly uneducated, dressed in the height of fashion, walking round from one public house to another, getting hold of these men and trying to induce them to steal their master's diamonds, and generally corrupting them all round. Of course, such men as those would not give the natives a very exalted idea of our civilisation, nor did they tend to civilise the Kafirs, and it was to be much regretted that no law existed there for preventing the indiscriminate sale of liquors to the natives. It was all very well to say that the black man is as good as the white, but he had considerable experience of them in different parts of the world, and must distinctly say that the uneducated black man was not so good as his white brother, and that to treat a raw Kafir as a British subject, and confer upon him all

a British subject's rights, was a simple absurdity. The idea of giving a Kafir who had got £20 a year, either in food or money, the electoral franchise, was carrying household suffrage rather to an extreme; but such in fact was the case. These men ought not to have conferred upon them the rights of British subjects until they were capable of using them; they ought really to be treated as children, and to do so would be for the good of themselves and the whole community. By all means let them be treated upon every principle of justice and mercy, but still they should not be inculcated with the belief that they are as good as white men the moment they enter a British province. Another subject of remark, and let it be said with all due respect; for the missionaries had done a great amount of good, though they had, perhaps, been as much abused as praised, was, that in the whole of those diamond fields, among upwards of 10,000 Kafirs, there was not a single European missionary at work, though there were two or three native missionaries, who were, no doubt, doing very good work in their way. Had missionaries been there, however few conversions they might have made, they would still have shown the Kafirs that, at all events, there were some Christians who had ideas beyond mere money-getting. It was to be doubted whether the annexation of the Transvaal, or of the district of the diamond fields, would in any very short time tend to the civilisation of the races of South Africa, but it would do so in the long run beyond question. They would have to wait for its development, for Christianity among these races made its way very slowly; but, for all that, it would come eventually, and the further British influence progressed northwards in South Africa, the more civilisation would advance with it.

Mr. Bergtheil said, though he felt bound to differ from Mr. Fynney in some of the opinions he had expressed in his paper, it was merely to give other gentlemen an opportunity of expressing their views. He had hoped to hear from the announcement of the paper how far the annexation of the Transvaal would tend to the civilisation of the Zulu races. Mr. Fynney had great experience of them, was thoroughly conversant with their language, well acquainted with their habits, and had given a very good sketch of them and their chiefs; he wished as much could be said of the manner in which he had alluded to the Dutch Boers, whom it had become too much the fashion to abuse and throw all kinds of blame upon; but the fact was they were a much abused people, and had once been badly treated. So far from having merely left the colony, the truth was they were driven out of it, for there they could not exist, being continually interfered with by the Government, petted like children one day and the next opposed. Who would have submitted to such treatment? What course was left for them but to leave the colony and look after their own interests? They crossed the boundary with the sanction of the Government; and no sooner had they, after a great deal of fighting, established themselves beyond, than another governor arrived in the colony who "knew not Joseph." A few hundred men were sent to take possession of their settlement, and then the Boers were told "you can have a farm if you please, or you may go where you like." Mr. Pretorius, whose name had been mentioned by Mr. Fynney in his paper, and who was a brave and worthy man, notwithstanding all that had been said about him, in that old time rode 500 miles himself to see the governor, and state personally to him the condition of his people, but was not allowed to see him, and the result was that the whole country was at last proclaimed British territory. To his own knowledge the country had been handed over to a parcel of adventurers, and by such means the Transvaal, a free State, had had imposed upon it a governing body; it was not of the people's own free will that that had been done, but it was forced upon them, because, it was said, the English Government did not wish to extend their territory. For a time they had been allowed to rule over it themselves, but now was seen another state of things, in which he must say he had no confidence, though certainly Lord Carnarvon was a Secretary of State who, at least, knew his business. The same fate which had overtaken them six or seven years ago, when they were told to look out for themselves, might one day be the fate of Natal itself, if they were attacked by the Zulus. He unhesitatingly denied that they had ever practised slavery; on the contrary, the black men had been treated like their own children among the Dutch. The natives had been made honest and peace-loving by them, and could be trusted with property to the value of thousands without ever locking a door. Could the same be said now, after what had been done in the country? Could the Kafirs now be trusted with property and life? If the future government of the Transvaal were carried on in the same way as it had been carried on by the Boers, the same results would follow. He would only say, in conclusion, that he extremely regretted his inability to agree with Mr. Fynney's opinion, that the annexation of the Transvaal would, as far as the Zulus were concerned, bring about the result which he so confidently anticipated; and having said so much in reference to the Kafirs and their chiefs, he must repeat his own expressions of sympathy for the Dutch Boers, who had always been found a good, honest, and industrious race.

Sir G. Campbell, M.P., asked Mr. Fynney to explain the statement in his paper that whereas blacks were treated under the Dutch Government very differently from white men, they received under the British Government equal rights with them, the case of Natal having been instanced where a law had been passed entitling the natives to claim the privileges of Englishmen. He would ask Mr. Fynney to explain the real position of the natives in that respect, and to say whether they were entitled to the franchise on the same term as white men. to hold land on the same terms with them, and generally to state what their position was when they had consented to come under the law he had mentioned.

Mr. Moody thought they should consider the future of the Transvaal rather than what had taken place in the past, in which there had been something to the discredit of the English. The Boers had elected to go into the lands of the interior rather than submit to the British Government, and whatever their object might have been, their emigration had to be carried out under very arduous circumstances. After a time their independence was acknowledged, but they were subjected to great disadvantages. Not only had they to support their own Government, but they had, being so far inland, to pay duties for all the goods they received. Their difficulties, therefore, simply trusting to their own resources as they were, were very great. They were not a numerous people, indeed, they had but a small population scattered over an area nearly as large as France—only some 20,000 or 30,000 people. As soon as the diamond fields were discovered, and not before, attention began to be paid to them by the British Government; but no helping hand was stretched out to assist them in controlling the natives. Pressure was then brought to bear upon the Boers: first, their right to the diamond fields was contested, and these were ultimately annexed. Indeed, the wrong that had been done by the annexation of the Transvaal had since been acknowledged by the action which had been taken by the Colonial Government with regard to it. The next injury done them was that guns and ammunition were allowed to be sold to the natives at the diamond fields to the amount of £200,000 or £300,000, that is to say, the natives of the Transvaal were supplied wtth weapons by the connivance of the British Government, while at the same time, Natal and the Free State were prohibited from allowing the trade in arms. Then the Transvaal was taken over because the Boers could not defend it. That was a small part of what might be said on the other side of the question, and the

British, therefore, might very well consent to let byegones be byegones. There could be no doubt that the British Government had taken a very proper step in annexing the country. The inhabitants of the country looked upon it as a relief, and were glad of it. What was to be done with it now that they had got it? It was an interior state which had to exist by its own resources. All who had written and spoke upon the subject had agreed that in agriculture, in pasture, and in mineral resources it was an extremely rich land. Gold, diamonds, copper, and lead existed on every hand, but the country required communication with the coast to develop and utilise them. The nearest point on the coast in one direction was Delagoa Bay, which belonged to the Portuguese, and in the other, Natal, at a much greater distance, belonging to the British; and unless the Transvaal was enabled to develop the mineral resources which it possessed, the country would not be a gain to, but would remain a burden upon, the British Government for years to come. If, on the other hand, by means of railways, those resources could be developed, it would be an acquisition for which they might be very thankful; and he hoped the influence of the Society would, in some small measure, tend to bring about that result.

Mr. Botly, referring to the statement made by Mr. Fynney in his paper as to the ravages caused by the disease of red-water, by the *tsetse* fly, and so forth, recommended to his attention a remedy which was well known to agriculturists in this country, and was as simple as it was sure. A communication of the knowledge of it would be of great importance to the colonists.

Mr. Fynney, in reply to the remarks which had been offered upon his paper, must earnestly repudiate any desire, on his part, to under-estimate the Dutch. On the contrary, he honoured those brave men who went out, occupied the land, and conquered overwhelming difficulties in doing so. He did not desire to rake up old grievances, but could only remark that in annexing the Transvaal the British Government had been actuated by no desire to acquire fresh territory, but simply by the wish to lend that protection and aid which one white race should never refuse to another. That was their only reason, as danger lurked on every hand, and the whole community was threatened. The annexation having now been accomplished, no one would be so blessed by the change as the Boer himself. With reference to the other point which had been alluded to, that of the law which had been passed for the benefit of the native, it simply tended to give him power to hold land on the same terms as Englishmen, and in no sense conferred political franchise.

The Chairman, in the name of the meeting, offered Mr. Fynney the thanks of the Society for his able paper, and hoped to see him at no distant date once more amongst them.

SIXTH ORDINARY MEETING.

Wednesday, January 16th, 1878; William Hawes, Esq., F.G.S., Deputy-Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Ashwell, William Henry, Argyll-house, Bedford.
Barkworth, Thomas, Chigwell, Essex.
Beeman, Joseph Samuel, 182, Earl's-court-road, Kensington, S.W.
Bell, Matthew, Temple Works, Cursitor-street, Chancery-lane, W.C.
Bowdler, A. C., F.C.S., Church, near Accrington.
Brunton, R. Henry, F.R.G.S., F.G.S., 1, Oxford-villas, Balham, S.W.
Cook, Mr. Alderman Joseph, Mayor of St. Helen's, Lancashire.
Dale, Edward Robert, Glanville's Wootton, Sherborne, Dorset.
Fergusson, William, Gas Works, Neepsend, Sheffield.
Fung Yee, Mandarin, Interpreter to Chinese Legation, 45, Portland-place, W.
Garrett, Frank, Aldringham-house, Saxmundham.
Grieve, Thomas Kerr, Boston-road, West Dulwich, S.E.
Hamilton, Major Alexander, R.E., Aldershot.
Harris, C. J., 11, Kilburn-priory, N.W.
Howard, John, F.R.G.S., Topsham, Devon.
Marsland, James, 5, Three Crown-square, Borough, S.E.
Ménier, A. S., 153, Minories, E.C.
Otway, Arthur, 19, Cromwell-road, S.W.
Patzor, Robert Frederick, Stoke-on-Trent.
Smith, W. Shore, 30, York-place, Portman-square, W.
Tyacke, Richard T., Sir W. C. Trevelyan's School, Seaton, E. Devon.

The following candidates were balloted for and duly elected members of the Society:—

Bragge, William, Shirle-hill, Hamstead-road, Birmingham.
Crease, Major John Frederick, Eastney-barracks, Portsmouth.
Crisp, Frank, F.L.S., 5, Lansdowne-road, Notting-hill, W.
Downing, Nicholas Berriman, Eastfield-lodge, Walthamstow.
Glover, Henry, Wellington-road, Bow, E.
Lumsden, David, Telegraph Department, General Post-office, E.C.
Ranson, Farrar, Lowestoft.
Shakespear, Colonel John D., F.G.S., Scientific Club, 7, Savile-row, W.
Whitmore, Lawrence Hersee, 124, Sloane-street, S.W.

The paper read was—

ON THE MANUFACTURE OF INDIA-RUBBER, AND ITS APPLICATION TO TELEGRAPHIC PURPOSES.

By **Thomas T. P. Bruce Warren**,

Analytical Chemist to the India-rubber, Gutta-percha, and Telegraph Company, Silvertown.

Before entering upon the general discussion of this subject, it may be necessary to offer a few remarks by way of preface.

During the last ten or twelve years india-rubber in its various forms has been prominently brought forward as an insulator for telegraph wires. Its use has been attended with somewhat questionable success, so that the confidence which was once placed on it is so shaken as to lead us to believe that the time is indeed very far distant before it will be again adopted for any important submarine work.

It is my intention, this evening, to lay before you an impartial examination of the history of some of the more recent facts developed, more particularly by the manufacture, laying, and repairing of telegraphic cables. I cannot help saying that my conviction is not unfavourable as to the suitableness of certain forms of india-rubber as an insulator for submarine cables, and in putting the following remarks together, I have, I hope, avoided a fulsome eulogy of its merits, and a gloomy parade of its misgivings. I believe nothing tends more to restore lost confidence than a frank and open inquiry, whatever might be the matter to be submitted to inquiry, and I know for a fact that frequently

scientific deductions have been laid aside because of their involving a possibly unpleasant improvement. It appears to me that the reputation of india-rubber manufacturers would be rudely tampered with, if any one asserted that this material was hopelessly shut out as a competitive insulator for submarine telegraphy.

This Society, through the medium of its *Journal*, has always shown a deep interest in india-rubber, and, without any fear of being contradicted, I may say that it has acted as a faithful recorder of all that has been revealed to us, having a botanical, chemical, geographical, or generally commercial interest.

With this fact in view, I thought that the present paper would be more suitable for discussion here than elsewhere. This much is certain, that our submarine cables do not show that immunity from decay, whether insulated with india-rubber or gutta-percha, as to secure for either of them more than an indulgent monopoly, which must ultimately give way to the survival of the fittest. It is well known that gutta-percha cores improved immensely with the development of a rivalry in manufacture, and to this circumstance we ought most hopefully to look forward for the amelioration of india-rubber insulated wires. Where skill and care are the solely guiding influences in a manufacture, success is certain, whilst monopoly tends to bring these wholesome agents to an insecure and uncertain limit. It seems difficult to deal with inventions on this point; but no amendment to our Patent-laws can be perfect so long as an inventor can secure one thing, and by it develop another idea, which, though bearing a faint resemblance to the original, is sufficient to close the road to advancement.

I am confident that the Patent-laws have done but little to forward the development of india-rubber in this very important branch of its manufacture. Improvements have been stultified to so glaring an extent that whereas, some few years ago, it was impossible to commend india-rubber too highly, it is now, in the opinion of many, completing the ebb of an ephemeral existence.

I am not aware that any one has attempted to formulate a method by which an inventor may be assisted in investigating the suitability of a material for an insulator, and, in bringing before you my experimental researches on india-rubber, I shall endeavour to describe the different methods of testing the properties of an insulator, so far as may be required for the purposes of submarine telegraphy.

There are not many materials suitable for insulators for telegraph wires besides india-rubber and gutta-percha. Simplicity of chemical structure is one of the most important considerations, for, as a rule, the less complex bodies are in their chemical constitution, the more stable will they be; consequently, chemists are disposed to look only on such bodies into the composition of which hydrogen and carbon alone enter, as applicable for insulating telegraph wires. Gun-cotton, when pure, and applied in the form of collodion, is a very good insulator. The difficulty which appears to me to operate against its use is the fact that the solvents which, commercially, can be used with it, are not insulators at all. Parkesine, xylonite, and xylodin are forms of pyroxoline insulators.

In 1863, I discovered that iodine, bromine, and chlorine converted india-rubber into a condition approaching that of vulcanisation, and in 1871 I patented its application for insulating purposes. Vulcanised oils are also very durable materials, and, as insulators, possess some very remarkable qualities. I believe these oils offer a very great temptation to an experimentalist who can devote time to their research. As regards price, there is no material which approaches them in lowness of cost. There is every probability that they will, when properly prepared, remain unaltered for a very long time. There are some specimens before you which have been made over 12 years. Ozokerite, anthracene, and paranapthaline are hydrocarbons which have also been proposed as insulators. Paraffin is a material which is very extensively used for some purposes. Its cost and durability are in its favour, and the same may be said of ozokerite. Professor Abel, in his address to the Telegraph Society, mentioned hatchettite* as being worthy of attention. All of these are mineral hydrocarbons found in this country.

Mineral caoutchouc, a substance which has been generally overlooked, also deserves attention. Its limited supply may probably operate against it. I believe no one has examined the electrical qualities of either of these substances, hatchettite or mineral caoutchouc. Professor Tennant has kindly lent me some specimens of these hydrocarbons, which are now before the meeting.

Viscin, a well-known vegetable substance, and one which may be abundantly obtained, is an insulator, appears to me to offer some points of interest in this direction.

Anthracene and napthaline, when incorporated with gutta-percha or india-rubber, were proposed as insulators by Messrs. Perkins and Tandy. Anthracene is at present too costly an article for this purpose, but napthaline could be obtained, I believe, at a low cost if required.

Candle tar and candle pitch, which are products resulting from the destructive distillation of the residues from cotton-seed oil for the production of stearine, have recently been patented as insulators, and form, I believe, the basis of what is known as "kerite" insulated wire. These materials undergo very singular changes from oxidation, and a kind of drying up which renders them brittle after a little time.

The incorporation of paraffin and ozokerite with india-rubber and gutta-percha have been lately referred to by Professor Abel as being, from the stable character of paraffin, and its homologues, likely to lead to important results. Mr. John Mackintosh patented, some years ago, the mixture of gutta-percha and paraffin, but I am not aware that it ever became a commercial article.

Messrs. Field and Talling have recently proposed a mixture of ozokerite, or some preparation from this substance, with india-rubber, which is said to possess some very remarkable electrical qualities.

Through the kindness of Mr. Gray, of the India-rubber, Gutta-percha, and Telegraph Works Co., Silvertown, I am able to lay before you a collection of very interesting specimens of india-rubber cores and cables, and other articles manufactured

* A specimen of the hatchettite or mineral tallow is exhibited in the Museum of Geology, Jermyn-street. Case C.

for telegraph purposes. Mr. Hooper, of Hooper's Telegraph Company, Mr. W. T. Henley, Mr. Wray, and Mr. Field also kindly supplied me with some specimens of their manufacture.

The methods which have been used for testing the suitability of india-rubber may with every convenience be adopted for carrying out a similar inquiry on any other material, I shall therefore lay before you an examination of the principal properties of india-rubber which have a special bearing on this subject.

I have often thought that there is a want of some definite help to those who are not immediately interested in the science of electricity, and who may contemplate turning some attention to the development of an insulator; although we have recently had numerous additions to the literature of electricity applied to telegraphy, I am not aware of anything being written to supply this want.

The absorption of water by insulating substances is a matter of important consideration. The methods which have been adopted, although sufficient to determine, in a general way, whether an insulator is likely to be seriously affected by the permeation of water through any depth of its substance, are followed by very conflicting results, in the quantity of water absorbed, and the rate of penetration. The nature of the absorption is somewhat peculiar, in being accompanied by singularly interesting phenomena, which I am not aware anyone has previously examined.

The purer the water is, the greater is the rapidity with which india-rubber and similar substances take it up. Distilled water, rain or river water, sea water, or strong saline solutions, are each marked by a special facility for hydrating. It is slightly increased by high pressure, although a moderate pressure will show a greater rate of absorption. Heat very sensibly affects it, being perceptible in a very short time, the higher the temperature is carried. As we approach the freezing point it becomes lessened to almost an inappreciable degree, unless under a very protracted immersion.

In operating with sheets of insulating substances, the usual plan has been to determine the increase of weight corresponding to some fixed unit of area, after an immersion of several days. As the thickness has no influence on the rate of absorption, the best plan, I have found, is to use sheets so thin that the area of the edge may be omitted, so that they present an even surface of exactly 50 inches on each side. When recently immersed they should be carefully weighed every day for at least a fortnight, as during this time a greater amount of water is absorbed, generally speaking, than will be visible for some months afterwards. After a few months' absorption the rate of absorption is so slow, that it will be sufficient if the weighings are taken at intervals of three or four months. After three or four years' immersion, the increase of weight is so slight that unless every precaution is taken to weigh rapidly, so as to avoid loss from evaporation, a decrease rather than increase may easily be found. Before each weighing, the sheets should be slightly rinsed in distilled water, so as to remove the slimy matter which accumulates on their surface, as well as to prevent any augmentation in weight from saline matter left on evaporation of the water. The omission of these or similar precautions will account for the discordant results which have been found by different experimenters on india-rubber and gutta-percha.

Sometimes it has been the practice to test these sheets electrically. Should this be continued, it is better to have several sheets of the same substance and of identical thickness; for, in preparing the sheets for an electrical test, there is of necessity a removal by evaporation of some considerable portion of the absorbed water. After washing and drying the sheets between folds of filtering paper by slight pressure, the edges may be pared away so as to make sure that no leakage of electricity takes place directly over the surface. It is more troublesome to test sheets of insulating materials this way than is generally supposed, or, at first sight, may appear to anyone who has not conducted this kind of experiment; and, to obviate the uncertainty likely to result, as well as to facilitate the testing without involving the removal of the moisture from the part to be examined, I have adopted the following method.

The sheet, when prepared, is carefully smoothed down on a metallic plate or disc, which is in communication with the earth; a small disc of tinfoil, about an inch in diameter, is carefully pressed down on the upper surface and kept in its position by laying upon it a small weight in the form of a segment of a circle; the surface of the sheet around the weight and disc is well dried by passing a warm knife around, so as to give about half-an-inch of dry surface between the disc and the other portions of the sheet; the leakage then can only take place through the sheet. It is, however, important that a very slight surface conduction, if any, shall be allowed to take place.

Any portion of the surface of a sheet may be so tested, without any paring away of the edges. It now remains only to charge up the weight, connected with the electrometer, by means of a small electrophorus, and to note the loss which then takes place. It is obvious that we could not depend upon sheets which are now and then kept out of water, for this purpose, to give a fully reliable indication of their absorbent qualities. The advantage of having several sheets is that, if one should give an unfavourable result, a means is at hand for verification or check.

I have examined sheets of india-rubber, gutta-percha, compounds of india-rubber, both vulcanised and unvulcanised, by this method, after immersion in sea water and river water for twelve years, and the general deduction is that, whilst some materials incorporated with india-rubber retard its rate of penetration to an enormous extent, it still takes place to a degree which would render its use in water extremely undesirable. Gutta-percha, and some forms of vulcanised india-rubber, do not indicate any deterioration from this cause. Pure vulcanised rubber, as well as its masticated form, completely loses its insulating property after a few years. Vulcanised india-rubber, containing tar, oxides of zinc or lead, plumbago, lime, and charcoal, are seriously affected by an immersion of three to five years, whether in river water or sea water.

Compounds of india-rubber, which, when vulcanised, show an efflorescence of sulphur on their surface when exposed to the air for a short time, absorb water very rapidly, especially if taken

out after some little time and exposed to the air, then returned to the water again, and this repeated at intervals of a month or so.

Whether this singular phenomenon is met with in gutta-percha, I cannot say, but as it appears with vulcanised india-rubber, in proportion to the exudation of sulphur, I should think that it can only happen where apertures or pores are created by the escape either of solid or gaseous matters.

To determine finally the amount of water absorbed by any material, it should be first carefully weighed and dried very uniformly with weighing at intervals, according to the loss between two successive weighings, until a constant weights is obtained. It not unfrequently happens that a loss of from one to two per cent. is perceptible on the original weight of india-rubber, and some compounds of india-rubber with sulphur. This fact, I believe, was first pointed out by Siemens, who considered that india-rubber underwent some form of dissolution in water. Although no satisfactory conclusion has been drawn from this statement, it is, nevertheless, an important statement, and, so far as I am aware, has been entirely overlooked. The accumulation of a slimy substance on the surface of the sheets of india-rubber takes place more readily on the masticated form. I believe it arises from the septum-like action of the rubber, causing a deposit of the collodial matters held in suspension in the water, for the accumulation of it is far greater than can be accounted for by the loss in the original weight of the masticated sheet.

From some recent experiments which I have made on this matter, it appears that india-rubber is capable of separating water from substances dissolved in it, so that when a piece of india-rubber is immersed in a saline solution, it absorbs the water with only a very small proportion of the substances dissolved in it. This may probably explain why the absorption of water is greater in proportion to its freedom from foreign matter.

A very convenient way of testing the amount of water taken up by an insulator, or other substance, is to cut the same into thin slices, and place it in an air-tight desiccator, over strong commercial sulphuric acid. Volatile substances given off by an insulator can also be readily determined by the colouration of the acid. This takes place to a remarkable extent with gutta-percha, and is slightly visible with masticated india-rubber. In this way I find that gutta-percha takes up from 3 to 8 per cent. of water in its manufacture, whilst vulcanised rubber retains from 6 to 10 per cent. Consequently, an Atlantic cable will contain about twelve tons of water. It is impossible to say what effect may follow from this water of hydration, which is diffused through the whole substance of the core. Looking at this in a commercial way, it certainly is a very heavy water rate, considering it goes in at the price of the insulator, and represents a value of nearly £10,000 sterling. With vulcanised india-rubber, it would be fully equal to the double of this.

Manufacturers of gutta-percha cores are giving attention to this subject, and although, perhaps, it may be impossible to eliminate this moisture altogether, there is, nevertheless, a great probability of its being very much reduced. This forcibly impresses upon my mind a fact which experience has led me to form, that while manufacturers of india-rubber have been generally willing to let chance help them out of their difficulties, manufacturers of gutta-percha cores have always lent an attentive ear to what science may have shown as being worth attention.

Although the absorption of water by india-rubber was made the principal objection to its use, I fully believe that prejudice against the material in any form, acted as a terrific barrier to an impartial consideration of its merits. A weak point was found in this, and no neglect was shown to use it.

The most convenient way of testing electrically the effects produced by the absorption of water, is by making the insulating material into the form of small bags, which, when filled with water, have their apertures closed with a metallic stopper, reaching down into the water. The part projecting from the neck is so finished that a connection can be made for the purposes of testing.

Care must be taken that all the seams are absolutely perfect; where vulcanisation is practicable there is no difficulty in securing this.

We have the advantage in this, that we do not interfere with the absorbing action of the material, nor do we involve the difficulty of dealing with a damp conducting surface, nor evaporation. All that is required is to secure an electrically clean surface for a little distance all round the neck of the bag.

The bags may now easily be tested by means of an electrometer, in noting the loss for any fixed but constant period, or by means of a galvanometer, in taking a discharge test, in the usual way of ascertaining the loss on insulated wires or cables, the bag being nearly immersed in water.

Every material which I have tested in this way has shown a decided permeation. Some materials have decidedly lost their insulation, whilst others were less effected by experiments which were carried out in this way for an uninterrupted period of twelve years.

Some experiments are on record where certain deliquescent or hygroscopic substances have been enclosed in bags in this way, and then immersed in water. The late Dr. Miller, of King's College, reported that bags made of india-rubber and gutta-percha, enclosing carbonate of potash and chloride of calcium, had absorbed considerably more water than sheets of the same materials with corresponding areas placed in water. Acetate of potash enclosed in a bag of india-rubber was found liquefied after a short time. Dr. Miller observed that, as the insulation of the bag was unaltered, the water had probably found its ingress through the imperfect sealing.

A short time ago I performed some experiments with bags filled with water, and placed in a vacuum with strong sulphuric acid, and in this way I found it possible to detect, by an electrical test, the permeation of water in a very few weeks. Probably the action of deliquescent substances in increasing the absorption may receive some explanation from this fact.

When experimenting with bags, I have invariably adopted the precaution of having three or four of the same material, and when found defective, I have, in order to leave no doubt in the result, tested different parts of the surface in the same way which has been given when speaking of the sheets.

If these bags are filled with water at different temperatures, they afford a very interesting method for observing the changes in insulation brought about by changes of temperature.

It may be remarked that none of these conditions are similar to what is met with in a submerged cable or core. This I grant, but still it furnishes an economical and certain test as to the suitableness of an insulator for submarine cables, and provides us with methods for operating on attenuated thicknesses not easily attained when applied to cores, in which case it is possible to arrive at a result in a few weeks, which could only be attained at the end of several months.

For testing short lengths of insulated wire, I have found the following very convenient and well adapted for laboratory experiments. The wire is bent into the form of a horse-shoe, and the ends passed through a perforated cork fitting tightly into the neck of a tall and narrow beaker; a third aperture has a glass tube extending an inch or two above the cork and reaching nearly to the bottom of the beaker; through this is inserted an earth wire for testing, or a thermometer. The whole is carefully sealed with paraffin. I have frequently kept insulated specimens this way under examination for three or four years without finding it necessary to recut the ends. The water is thus prevented from evaporating or damping the ends, and effects of temperature can be most conveniently observed. All insulators absorb water more or less, and the results of observation is that it probably is not limited by time, but what the practical effect of this minute quantity of water has on the durability of cables remains to be answered.

When a piece of masticated india-rubber or gutta-percha is carefully dried, and then hung up in a ordinary room, it will be found to answer the purpose of a hygrometer; this tendency to absorb water shows itself by the manufactured articles containing more or less water. If india-rubber or gutta-percha be cut into thin slices and placed in a desiccator over a little sulphuric acid, it will be found to lose weight for some days. From experiments made in this way on a piece of Atlantic core, I find that an Atlantic cable contains about 3,000 gallons of water. A similar cable with an india-rubber core would contain over 10,000 gallons of water in the form of moisture.

The greatest improvements which can take place in the manufacture of telegraphic wires will be in reducing the penetration of water. A material pervious to water is unsuited to telegraphy. It is well known that both india-rubber and gutta-percha, when exposed to the air, become conducting, and this arises not from the fact of any conducting substance being formed, but because a greater tendency to absorb water has been created. From this it is obvious that no examination of the absorption of water by a material can be considered perfect without ascertaining the effect produced by occasional exposure to the air.

I have repeatedly heard it said that cables are manufactured to be kept under water; but there are times when this is impracticable, for instance, when shipping, laying, or repairing.

Leakage of tanks has been a fruitful source of mischief with india-rubber cores, from the fact of such cables being dry and wet alternately, which, I believe, is the most severe trial to which any core can be submitted.

A piece of india-rubber core, if confined in a close room or store, suffers much more seriously than if exposed in some situation where a free circulation of air can take place. I have seen leading wires which have been in use for ten years, remain perfect, stretched across an open yard, and exposed to all kinds of weather. Similar wires laid in troughs, along a cable factory, have become seriously faulty within two years of their erection. In the one case, air, light, and heat have fair play, to induce decay by oxidation, whereas, in the other case, the conditions favourable to oxidation are reduced to a minimum. This affords a striking contradiction to the statement that oxidation is the cause of the want of permanence in india-rubber covered wire.

I remember some time ago a case where several miles of wire were manufactured, and of such dimensions that it was thought impossible for it to be otherwise than perfect. This core was not put into water until some months after its manufacture, when its insulation was found so low that the whole of it was absolutely useless.

As recently as the years 1861 and 1862, the insulating properties of the india-rubber wires then manufactured were so perfect that there was no galvanometer in existence sufficiently sensitive to measure, except by approximative calculations, the leakage from an ordinarily covered wire much under a mile in length.

To my mind, it is difficult to point to a fact more in illustration of the march of progress than this simple statement. At the present time instruments capable of measuring with precision the leakage on the most perfect wires, not more than 100 yards in length, are not only to be found in the laboratory of research but are now ordinarily in use in factories. India-rubber manufacturers, I may safely say, obliged our scientific instrument makers to open their eyes to the deficiency which was then made patent to them; and with such alacrity was the matter handled by them that, within two or three years of the necessity arising, galvanometers of extraordinary perfection were within the reach of every experimentalist.

I do not suppose anyone would revert to the methods of galvanometric measurements then used. Let anyone who contemplates the investigation of the properties of an insulator at the present time reflect that in 1862 a telegraph engineer could scarcely report on less than a mile length of covered wire, whereas, with the present appliances and methods of testing, a perfect examination can be effected on lengths of two or three feet. In the one case, in addition to the outlay involved by the extra material, there was the very important consideration of constructing machinery, whereas a little skilful manipulation will enable almost any material being tried with a very little cost in the way of appliances.

Future inventors need not incur more than a mere fraction of the expense in developing the practicability of a material as an insulator which has had to be incurred with india-rubber or gutta-percha.

After having satisfied oneself with the behaviour of a material by these preliminary methods, the

expense of manufacturing longer lengths, with suitable appliances, may be judiciously incurred.

It is a mistake which has often been made, and indeed occurs every day, and is not confined to any particular branch of study, that a very heavy outlay is made upon an idea which, at best, would be but lumber to a lumber-room.

Infatuation adds largely to the income of the Patent-office, and it is a notorious fact that not a single patent taken out for insulating with india-rubber is now worked. I mean the materials or its combinations.

It must not be taken for granted that because a material works well, and behaves satisfactorily with our laboratory operations, that in practice no difficulty will be met with. It more frequently happens that, when working on a large scale, we meet with circumstances wholly unforeseen, and which no forethought could have provided for. Now, to a very great extent, this has to be said for india-rubber insulation, and I believe nearly every manufacturer has found that, when working with india-rubber on a large scale, difficulties have cropped up which have been sufficiently serious that a requiem would have been its certain fate, if met with in the days of experimenting.

Future inventors must not be deterred by these remarks. We have to bear in mind that the attempt to connect this country with America by a telegraph cable had hopelessly failed; sufficient, however, had been realised to show that it was possible to telegraph between the two continents. Many attributed the failure to the insulator, which was gutta-percha; and, as india-rubber had been previously employed for land lines, and had never failed across the Atlantic—as it had never been tried—what could be more natural to the mind of an inventor than to give some form of india-rubber a trial? This was followed by a general scramble in the way of patents for cables and india-rubber insulation, and, viewing the result gained by the experience of time, I think it would have been the most unfortunate thing that could have happened for submarine telegraphy had gutta-percha been abandoned for india-rubber in any form which then was proposed. However high may be the resistance to leakage by an insulator, if it does not possess durability in this respect, it is quite unsuited for submarine work.

In testing the suitability of a material as an insulator, it is important to ascertain the relative value of different thicknesses as regards permanence, and, in cases where it is desired to ascertain as quickly as possible whether a material is fitted for submarine work, it is best to operate on wires with the least thickness of the material which can practically be put on, so long as a perfect coating can be secured.

I seriously question whether, if this had been done a few years ago with india-rubber, we should have ever had a submarine cable manufactured with it at all. At the same time, probably other forms may have been introduced different to what we now have, for the very earliest experience of vulcanised india-rubber in thin coatings showed that it was certainly not durable. I believe that, had the matter been fully investigated, it would amply have rewarded any manufacturer, and, instead of our having to record a series of failures, more or less extensive, we may at this time have been able to point to the introduction of india-rubber cores as marking a new era in submarine telegraphy.

It was a great difficulty to secure a trial for india-rubber on a practical scale, and I think it is not improbable that the same struggle would have to be encountered again by any new form of insulator. Submarine cables are too costly in every way ever to be made the subjects of experimenting, and this being the case an inventor who has the good fortune to obtain an introduction for a new material has great reason for being thankful. This, however, would be less thought of, if the general public had or felt a greater interest in telegraphic investments, which would relieve contractors from the heavy responsibility of financing. Telegraphic cable manufacturers and contractors cannot be censured for a rigid adherence to a well-tried insulator, and our recent experience of india-rubber fully justifies their conduct in this respect.

Inductive Capacity.—Although we have lately had many useful additions to the literature of electricity, I do not believe that there is a single treatise which contains so clear or so interesting an account of this phenomenon as the "Science Manual on Electricity," by Professor Fleming Jenkin, and as it is not my intention to dwell on the electrical aspect of this subject, I would refer anyone who wishes for information on the methods of measuring the electrical resistances or capacity of an insulator to this compact and useful volume. The fact that india-rubber had a lower capacity than gutta-percha, brought this substance into prominent notice. Sir Charles Wheatstone stated that a coating of india-rubber of a given thickness was fully equal to a coating of gutta-percha of double this thickness, Now, as the materials have nearly the same specific gravity, this means that a given weight of india-rubber is equal to four times its weight of gutta-percha, so that the insulating portion of a cable, which is by far the most expensive part of it, supposing the materials to be the same price, would, with india-rubber, amount to only one-fourth of what it would be with gutta-percha. That is, a conductor coated with india-rubber should cost a little over one-fourth of what a similar conductor coated with gutta-percha would amount to.

I do not believe that the energy devoted to this matter has been in any way commensurate with the commercial importance of such a fact.

It is by no means desirable to use too thin a coating of any insulating material, since it is shown that faults are more liable to happen with thinly-covered wires. I would venture to say, that if telegraph cables were articles of daily demand, and not so much the subject of monopoly, we might long ago have had some important additions to our lists of insulating media.

I would, however, from what has happened with india-rubber, advise no one working on an insulator to take up a stand upon the questionable merit that less material may be used. If, instead of india-rubber being capable of replacing gutta-percha, by using diminished bulk, it had been proved that, whilst giving the same security, it admitted of the same reduction in cost, india-rubber must have forced itself forward.

An insulator, to stand any chance of commercial

success, must be, bulk for bulk, much less than gutta-percha, for we must remember that with a tried material much less risk is incurred than with a new substance, upon which experience has to be gained, and in no case is it possible to be attended with more serious consequenees than in the application to an important submarine cable.

In semi-vulcanised india-rubber cores of large size, the inductive capacity is generally about 20 per cent. lower than gutta-percha cores of the same bulk, but with small cores it is not unfrequently 5 to 10 per cent. higher. This, I believe, is due to the heat in vulcanising.

This is a portion of the subject upon which hinges all the importance of india-rubber. It was its low inductive capacity, compared with gutta-percha, which brought it into notice for cable work. Much more may be said on this matter, particularly as to the proportions of conductor and insulator best suited for cable work; this, however, would require my enlarging on the details and manufacture of several submarine cables, which would occupy more time than the present paper would allow. I would simply add that the advantage of india-rubber in having a low inductive capacity, tending to its use in diminished bulks, has been a very serious mistake in practice.

Manufacture of India-rubber Insulated Wires.—The method at present in use for applying india-rubber, or compounds of this substance for insulating, are but slight modifications to those proposed on its earliest introduction, In fact, the machine employed in lapping india-rubber tapes around the conducting wires differs in no particular from that described in the patent of Moses Poole, in 1852. The first patent for applying vulcanised rubber was taken out in this country by Mr. Goodyer, in the latter part of the same year. The mechanical arrangements for putting india-rubber on longitudinally, are similar to that patented by Messrs. Barlow and Forster, in 1848. The only improvement worth mentioning, which has lately been introduced, is that of the Silvertown Company, by which several wires can be coated at the same time. By this important arrangement one machine can produce about 10 miles of covered wire per day, with one-twentieth part of the labour required in the ordinary way. One very serious drawback to the security of the manufacturing processes, has been the difficulty of concentrating the responsibility. Every mile of wire manufactured in the ordinary way, requires the independent supervision and attention of four or five hands, each of whom, by a simple act of omission, may produce serious faults, without affording any clue as to who should be blamed for it. The fact of simplifying the manufacture enables us to employ a better and more skilled class of labour, with a great reduction in the way of supervision.

I think there is every probability that india-rubber wires will attain a more certain and satisfactory character, in proportion as manufacturers realise the importance of skill, care, and cleanliness in every department connected with it. The fact of not been able to refer a defect due to absolute carelessness to some responsible workman, has contributed very largely to the difficulties which have arisen in connection with many india-rubber cables.

I have heard it frequently said that skilled labour is not at all necessary for this description of work. Looking at these facts, we must be cautious in attributing to india-rubber itself, the misgivings which have arisen mainly from the want of proper precautions in dealing with it. Although the manufacture of gutta-percha cores is immensely more simple than india-rubber wires, the most careful and experienced hands are employed in every stage, and I believe this is the grand secret in the success which has lately attended gutta-percha cables.

The form of india-rubber wire which has been almost exclusively employed for submarine cables is that known generally as Hooper's material, and which, in fact, consists in applying a coating of vulcanisable rubber over a coating of masticated rubber, with an intervening layer of compounded rubber to arrest the passage of the sulphur, during the process of vulcanising, from the sulphur compound to the inner masticated rubber. This form of wire has been also manufactured by the Silvertown Company, Henley, Siemens, and I believe by the Telegraph Construction Company.

The separating media first proposed consisted of hemp, metal foil, iron wire, and varnished cotton tape. It is obvious that the use of any of these materials between two insulating coatings would have been sufficient to prevent such a wire from having any extensive application, and consequently india-rubber, compounded with metallic oxides, was used instead.

The red oxide of lead and oxide of zinc were the only two used in practice. The red lead was found to keep back the sulphur from the inner layers almost effectually, a mere trace of sulphur being found to have penetrated through it. The quantity of sulphur which I find passes through a layer one thirty-second of an inch thick of a mixture containing 5 lbs. red lead, and 32 lbs. india-rubber, is about one-fifth of what would have penetrated through the same thickness of india-rubber. I have not been able to determine any difference between the quantities of sulphur which pass through the same thickness of masticated rubber, and rubber compounded with oxide of zinc, plumbago, alumina, or silica, in the proportion of 5 lbs. of each to 32 lbs. of india-rubber respectively. When, however, the india-rubber is compounded heavily with French chalk or with any of the above substances, a very different effect is produced. Equal parts of india-rubber and French chalk applied between a coating of masticated rubber and a sulphur compound, allows only one-fiftieth part of the sulphur to penetrate, which would have passed through the same thickness of masticated rubber. Two parts of French chalk and one of india-rubber has only the effect of keeping back one-tenth. The effect produced by the further diminution of French chalk is more marked as we approach the proportion of five parts rubber and one part French chalk. A further reduction is followed by very slight differences, the sulphur being kept back, but little more than a similar thickness of india-rubber would have effected.

In carrying out these experiments, slight differences will be met with, according to the amount of grinding given to the compounded rubber. An extra amount of working will make the compounds more effectual in arresting the passage of

sulphur, and this I believe is due to the fact that the rubber itself more readily holds it.

A very instructive series of experiments may be made to ascertain what is the lowest amount of sulphur which, when thoroughly diffused in india-rubber, will prevent its decomposition. It is well known that very small proportions of sulphur will prevent india-rubber from being so readily acted upon by solvents, or changes of temperature, one thirty-second of a grain per cent. of sulphur has a marked effect when placed in a solvent, althouh it is capable of hardening by cold.

A great deal has been said lately to the effect that india-rubber cores are not so durable as when they were first made, and attempts have been made to explain this phenomenon, which to my mind are by no means satisfactory.

The amount of sulphur usually found in the earlier specimens varied from ·75 to 1·2 per cent., when compared with the weight of the inner layers of india-rubber. When placed in naphtha it swelled, but did not dissolve when heated, or by long immersion. Wires of recent manufacture show a decidedly soluble condition, and on analysis give in some cases no indication of sulphur at all.

A paper was read by Mr. Collins before this Society, a few years ago, when it was suggested that an attempt should be made to introduce the species of siphonia yielding the best description of Pará rubber, into some of our colonies. I am not aware whether anything has been done in this direction, but as the varieties of the siphonia producing the Pará rubber of commerce grow only in perfection in damp and swampy localities, which are of necessity extremely unhealthy; I should consider the experiment one well calculated for carrying off the surplus population. I have seen the massaranduba growing in perfection in Pará; its growth does not necessitate the selection of damp and unhealthy swamps. It is a tree which, when well grown, is very ornamental and of great size, and might on this account well replace the mahogany tree for affording shelter from the sun if planted in avenues, whilst its production of caoutchoue would not be much diminished.

I think the attention of the Government may be drawn to this fact; for the gathering india-rubber is by no means, as far as I am able to gather, an unhealthy occupation, but it becomes so simply from the fact that the Pará rubber-yielding trees grow in very unhealthy localities. If the massaranduba could be naturalised in India, for instance, it would become an immense source of wealth. A specimen of this rubber prepared by myself is before you.

It has been said that greater care in collecting rubber from the trees yielding this substance, growing in Africa and other places, would bring the article in competition with Pará rubber. This is a great mistake, for the presence of resinous matter in the caoutchouc obtained from certain trees will always render the rubber clammy and soft. India-rubber manufactures are so rapidly developing that any additional source of supply will amply repay investigating.

I must apologise for this diversion from the subject of this paper, but india-rubber manufacturers would feel heartily thankful in being relieved from using rubber, which is now so much the matter of speculation as the Pará bottle rubber.

When I was in Pará, a line of steamers was proposed to call between Manaos and Liverpool. Now, as a very great deal of Pará rubber is collected in this province and is re-shipped at Pará, I suggested to a gentleman that it would probably lead to a great loss in the revenue to the Pará local government. I was informed that the province of Manaos was indebted to that of Pará, the result being that shippers at Manaos were obliged to put on an extra charge of 6d. per lb., which is paid to the Pará province. This is by no means a pleasant reflection for india-rubber manufacturers, especially as, I am told, the debt will require about fifty years to clear off.

Another fact is that the Brazilians, instead of having a fixed export duty on rubber, meet any deficiency in their local budgets by raising the tariff on rubber. This is a veritably elastic source of revenue.

During the last few years, great differences have been noticed in the behaviour of Pará rubber in certain stages of manufacture. I can hardly think that this difference has been overlooked by those manufacturers of india-rubber who are not interested immediately in its application to telegraphy.

In 1873, whilst I was at Pará, a Brazilian gentleman, Captain Bloem, informed me that there was a tree found abundantly in that province which yielded gutta-percha; on my next visit to Pará, he kindly procured for me about a quart of this juice, and informed me that the name of the tree yielding the juice is the Massaranduba, or cow-tree of Brazil. On examining this juice I found that it yielded india-rubber. An account of this appeared in the *Journal* of this Society.*

I have, since writing that paper, been informed by her Majesty's Consul at Pará, that this substance had been for about two years previously shipped as Pará-rubber. It is certain, however, that this practice must have been of earlier date, for Edwards, in his "Voyage on the Amazon," speaking of this tree, says, "its juice is used for the adulteration of Pára india-rubber." It is surprising, looking at the frequent reference we have from travellers, of the cow-tree, that so little attention has been drawn to it as a source of caoutchouc.

I have given some attention to the effects arising from the mixing of the juices of certain india-rubber producing trees with others, and I cannot help thinking that the want of permanence which has lately been found in india-rubber wires, may be, in a very great measure, due to the fact that Pará rubber of the present day is not of necessity the same substance as was met with a few years ago.

My analysis of the Massaranduba rubber gives:—

	Per cent.
Carbon	80·66
Hydrogen	11·52
Nitrogen	traces.
Ash	·33
Moisture	·38
Oxygen	7·11

The amounts of carbon and hydrogen contained in this substance, omitting moisture and ash, agree

* See *Journal*, vol. xxii., pp. 691 and 765.

tolerably well with the analyses of caoutchouc. Thus

	Carbon.	Hydrogen.	Loss.
Faraday gives	87·2	12·8	
Ure	90·0	10·0	
Greville Williams	86·9	12·4	·7
" "	87·3	12·1	·6
Massaranduba (Warren)	87·3	12·7	
" "	87·5	12·5	

We may, consequently, regard the pure hydrocarbon from the cow tree as identical in its composition with the caoutchouc obtained from other sources.

The mechanical properties of vulcanised india-rubber were considered at one time to comprise all that could be desired in an insulator for telegraph wires.

In its not being softened by heat, there was no liability to injury by being accidentally warmed, as by attrition, or by the compounds of pitch and tar which are applied to certain types of cable, for the preservation of their protecting covering, and which are of necessity put on hot.

Its non-liability to injury from percussion and straining, and its unalterability, as was at one time supposed, whether in air or water, were eminently favourable to its suitability to all the mechanical requirements in an insulator.

Its electrical advantages over gutta-percha was admitted by everyone. Gutta-percha, however, had the benefit of having been previously used, to the exclusion of everything else, and, as it had not been known to fail from inherent weakness in the material itself, those who were interested in its manufacture naturally preferred to develop more thoroughly the good qualities of this substance, than to embark in a new material, of which there was no experience.

With the most ordinary care employed in manufacturing cables, gutta-percha is not liable to receive any injury which the properties of vulcanised india-rubber might tend to ward off. Experience gained from the manufacture of several thousand miles of semi-vulcanised rubber shows that its mechanical advantages do not in any way render it less liable to injury from abrasion or percussion, but, on the contrary, it requires greater care in handling than gutta-percha.

Another advantage claimed for vulcanised india-rubber, since it was not liable to be softened by heat, was that it could be laid or shipped to warm climates without any chance of being injured. I may state, without fear of being contradicted, that here it has fallen very short of being even equal to gutta-percha.

From the fact that india-rubber in its vulcanised state was so proof to injury from heat, it was considered that cables containing cores of this material could be shipped dry, thus avoiding the outlay of tanks, and the carrying a large freight of water.

One would have thought that a single failure to sustain this quality in practice would have prevented the hazard of its being repeated. Suffice it to say, that this shipping of india-rubber cables, without the means of keeping them covered with water in transit, or manufacture, has seriously jeopardised the reputation of this material.

If it were possible to find a material which, with impunity, might be submitted to this treatment, it is highly improbable that any engineer would be willing to advise its submergence without the means of testing which water-tanks place at his command. Without tanks it would be almost impossible to recognise the development of a fault until after it had left the ship.

The elasticity of vulcanised india-rubber was considered an important advantage by those who were willing to claim some credit for every property which india-rubber did not share in common with gutta-percha. If, for instance, a sudden strain being put on the core ruptured the conductor, its elasticity would, on taking off the strain, cause the two ends to approach each other, thus restoring communication, whilst the elastic quality of the insulator accommodating the extension of the conductor, there was a diminished chance of deranging the insulating envelope.

I do not believe there is a single case on record in which any of these supposed advantages have resulted otherwise than in the most embarrassing direction. Whilst there may be the probability of their stimulating carelessness, it is certain they have not enhanced its merits.

I cannot help thinking that those who advocated the use of india-rubber for cables, by the enumeration of its mechanical advantages, could have formed but a very shallow idea of what was required. Cables are too costly, and the seriousness of faults too important, ever to allow them to be handled with carelessness or slovenliness. If we are to estimate the success of india-rubber cables, we must not lose sight of the factor due to an over-confidence in its mechanical character.

The effect of pressure upon india-rubber is said by some to improve the insulation, while Siemens asserts that it reduces it. My experience on vulcanised rubber and rubber changed by the action of iodine, bromine, and chlorine, is that pressure exerts no change on the insulating properties of any of these forms of india-rubber.

I have given considerable attention to the changes produced by changes of temperature on different kinds of this manufacture. I have not found with any description of india-rubber cores that the slightest permanent change is produced by any ordinary changes of temperature, unless the india-rubber itself is undergoing some kind of decay. When the inner layers of india-rubber are becoming soft and sticky from decomposition, a most marked difference is found in the temperature co-efficient; thus, I have found the co-efficient 1·026 for difference of 1° in a sound core increase to 1·045 in a few months. This is one of the most certain indications of an india-rubber wire decaying which I know of. It is a singular fact, too, that the inductive capacity is very much increased.

I am not able to give any explanation for these very curious results, but I believe that an examination of the properties of viscous india-rubber would throw some light upon it. I am surprised that these changes in india-rubber wires have been so completely overlooked, especially as they must have come under the notice of manufacturers some very long time ago. I feel confident that a re-examination of the causes producing the decay of india-rubber will lead to some very important results. It is by no means certain that the tendency of india-rubber to liquefy is a consequence of oxidation, especially when we bear in mind that this change frequently shows itself most seriously under conditions the least favourable to oxidation.

When a piece of india-rubber is suspended in ozone or ozonised oxygen, it does not liquefy or soften, but becomes much darker in colour, and loses its elasticity; but if a piece of india-rubber be heated in an atmosphere of carbonic acid, and then confined in a dark cupboard without access to air, it gradually takes a semi-fluid form. I performed these experiments some years ago, and have since repeated them, with the same result.

If a piece of india-rubber which has become blackened and rotten by exposure to the air, be digested in alcohol, it yields up a considerable quantity of a soft viscid resin, which, from the analysis of the late Dr. Miller, contains a large quantity of oxygen. If we examine the figures given by his analysis, it shows that the elements of caoutchouc are simply united to oxygen.* Here, then, we have direct oxidation, brought about under conditions most favourable to it.

A very important consideration arises from the fact that electrostatic capacity influences the rate of transmission in submarine cables. On land lines buried in the earth it is less felt in consequence of the diminished lengths of wire operated upon in a single circuit.

In consequence of india-rubber possessing a lower specific inductive capacity than gutta-percha, it was thought by many at one time that it would, to a very great extent, replace gutta-percha as an insulator for long lines of cable.

I cannot help remarking that I believe it would have been better for india-rubber had a little less attention been given to its inductive superiority over gutta-percha.

The lower inductive capacity of india-rubber pointed to several very important results, but these, I regret to say, have tended more in the direction of its ignominy than otherwise.

It is impossible to refer to any length of india-rubber covered wire which does not offer some illustration to this remark, and although it is a pity to sacrifice such an important feature in the character of india-rubber, it is a far more serious matter to manufacture important submarine cables with a risk to security.

Telegraph engineers, and those interested in the manufacture of india-rubber telegraph cores ought now to be satisfied that it is impossible, without very serious risk to efficiency, to economise the use of an insulator.

With gutta-percha cores, the tendency has been to increase the thickness of the insulator rather than to reduce it, whilst with india-rubber the opposite has been the general practice.

I believe no india-rubber core has yet been laid containing more than 150 lbs. india-rubber, and instead of such cables being made cheaper, as was expected from the fact that such small quantities of insulator could be employed, I have no hesitation in saying that their cost have been fully equal to that of gutta-percha cores amply provided with a safe and reliable proportion of insulator.

* Miller's analysis:—

Carbon	67·23
Hydrogen	9·54
Oxygen	23·23
	100·00
Or, neglecting the oxygen we get carbon	87·6
" hydrogen	12 4
	100·0

In signalling through long submarine lines, the rate of transmission, other circumstances being equal, is proportional to the logarithms of the ratios of the diameter of the insulator and conductor. A few years ago, Sir William Thomson showed that there was a certain value for the logarithm of this ratio which made the rate of signalling the greatest possible, so that by constructing a core with a given proportion between the diameters of its insulator and conductor, we obtain the full electrical advantages of the materials with the minimum of these materials.

In practice it is found that the thickness of the insulator would be insufficient to secure freedom from mechanical defects, and an increased thickness is therefore given which, whilst adding but little to the speed of signalling, reduces the chances of defects from mechanical causes, in proportion to the weight or diameter added to the core. From the fact that this function has been generally raised with gutta-percha cores we may infer that experience shows that what we regarded a few years ago as sufficient thickness of insulator may with advantage be increased. The generality of india-rubber cores have been insulated with such a proportion of material as has never been attempted with gutta-percha, consequently we have had increased liability to faults from accidents and imperfect manufacture.

It was thought that the mechanical properties of vulcanised india-rubber would have justified the employment of diminished bulks or thicknesses of insulator, and the manufacture of experimental lengths of core made this idea so feasible that no one can be blamed for suggesting the practical test of laying a cable in which such an important advantage could receive its full chance of being most thoroughly and impartially investigated.

This much is certain, that india-rubber has now had a fair and extended trial of how far advantage can be taken of its low inductive capacity to economise in bulk of insulation. I would venture to say that no one who has had any experience in this direction could give a favourable opinion for its repetition. I have seen lengths of india-rubber core—made with remarkable uniformity, and, apparently, absolute freedom from faults—develop faults in a very serious way, and, as I have reason to believe that there were no mistakes in the *modus operandi* or materials, I am compelled to say that india-rubber, in any of its forms, applied in thin coatings, is not sufficiently reliable to justify our continuing to reduce the bulk of it as an insulator.

Whilst most embarrassing results have been obtained in the manufacture of certain proportions of conductor and india-rubber, other proportions have been more successful; so that I believe it is by no means difficult to manufacture india-rubber suitable for any purpose of submarine telegraphy. From my experience of the manufacture of india-rubber insulation, I think what is most required to ensure success is simply care. I cannot see any process which can possibly involve the slightest difficulty, so long as successful workmanship is not made to follow in the uncertain track of economy.

A very great deal was expected from vulcanised india-rubber insulated wires, from the fact that this substance was capable of withstanding rough usage without any apparent deterioration. In

practice this is certainly not the case. I have seen several thousand miles of india-rubber core manufactured and shipped as cable, and I can only recall to mind two solitary instances of successful shipping and laying without faults.

Whether by more skilful handling and care the faults due to mechanical causes may be avoided, is uncertain, at least, when dealing with thin coatings of insulation.

With the past experience of india-rubber before us, I think it is a cause for congratulation that the proposition of laying an india-rubber core across the Atlantic has not been carried out, and I think that most telegraph cable manufacturers, and engineers, whether interested in india-rubber or gutta-percha, will be willing to allow that, whatever good qualities may belong to india-rubber, there has been a greater risk in manufacturing, laying, or shipping such cables than gutta-percha.

One striking peculiarity in india-rubber is the way in which faults of tolerably large magnitude diminish, and at times disappear. As this has sometimes happened during coiling, many have said that it is due to the bending of the core; no one could seriously entertain this idea who has had much to do with india-rubber core. In fact I have never seen a fault disappear by handling in any way. I have, however, seen many cases where faults have concealed themselves without handling, but only when the core has been highly electrified, with the purpose of enlarging a slight fault. This is easily explained. The india-rubber at the defective spot is, by the action of the current, liquefied, and this liquefied rubber being a good insulator, and insoluble in water, flows, partly by the pressure of the cable itself, into the hole, and completely seals it up. As this liquid becomes absorbed by the adjacent sound portions of the core, the water gains an ingress, which leads to the re-establishment of the defect with an enhanced magnitude. The hole which is found accompanying such a fault, most frequently contains in its vulcanised portions a quantity of carbonised matter, together with certain products resulting from the action of sulphur at elevated temperatures. This is one of the most troublesome faults met with in the semi-vulcanised form of india-rubber, and one which I believe has not yet been provided against. It seems to me that it is confined to those forms of vulcanised rubber containing red-lead and other oxides which are partial conductors and are capable of yielding up a portion of their oxygen. It is easy to see that if a small quantity of such an oxide, or even sulphur, were imperfectly blended with the rubber, it would leave a small aperture for the water to find its way into the more porous layers of unvulcanised rubber; electrolysis is then set up, and the heat, resulting in the fusion of the rubber, gives the fault for a very short time such a resistance that its locality can be ascertained, but this in a few moments so completely disappears that many would pronounce such a cable sound.

I recollect a case where such a fault was recognised during the shipping of a cable, but the cable was actually sent to sea. The removal of this fault probably cost over £4,000, and which might have been effected for less than £300 before leaving. The fault, however, had concealed itself, but it is a very dangerous practice to disregard the faintest indication of faults. The same cable was eventually laid in a faulty condition, notwithstanding the fact that two faults were removed before paying out. This is a case entirely due to want of prudence on the part of the manufacturer, but, to my mind, it may serve as an important lesson to anyone who would avoid, for any new form of insulator, an imperfect trial, in taking the advantage of a treacherous quality of a material.

The best plan is to make one's self thoroughly acquainted with all the weaknesses of a material, and by no means to attempt to conceal them from those whose interest it is equally important to serve.

I do not think sufficient facilities have been given to telegraph engineers to acquaint themselves with the peculiarities of india-rubber cores. There is, of necessity, a great deal more of mixing and working with india-rubbber than is required with gutta-percha, so that the material is, to a great extent, disguised when in the completed core. Gutta-percha is free from this.

I recollect, some years ago, hearing a gentleman who was more in favour of gutta-percha than india-rubber say, that india-rubber involved too many manufacturing processes and secrets ever to allow it to be much used. This is decidedly not my impression, for there need be no particular secrecy in its manufacture.

I have seen the specific gravity of india-rubber cores increase from 1·05 to 1·23, and in core made for the same cable I have seen it rise from 1·17 to 1·24. I would simply ask, if we meet with such wide differences as these, can we be surprised that india-rubber has failed to sustain its reputation? The increase in specific gravity means diminished bulk, and, consequently, increased tendency to faults from manufacture and handling.

It may be said that a security against such a case would be to specify the diameter rather than the weight of insulator for a core. This, I may observe, does not meet the difficulty more than half way, for it is possible to produce the bulk with such pigments as French chalk, which will only give a slight increase in weight.

India-rubber incorporated with certain pigments has a much diminished tendency to take up water, and on this account a pigmented rubber is decidedly preferable, but it is a matter which can not be too forcibly pressed upon the attention of manufacturers, that the quantity of foreign matter incorporated with india-rubber for insulating purposes should not exceed that absolutely necessary for manipulating or working.

Pure vulcanised india-rubber absorbs water more rapidly then masticated rubber. A compounded rubber gives greater firmness, which is an important quality in an insulator.

A few years ago I discovered the very curious fact that extra grinding or working india-rubber gave it a higher specific inductive capacity after vulcanising. As I did not test the rubber before vulcanising, I cannot say whether the effect is visible before curing. It certainly leads to very troublesome results, but is not nearly so pernicious as imperfect mixing or grinding. I believe imperfect grinding or mixing of the pigments with india-rubber has led to more trouble with some recent cables than is supposed. The consequence is that such rubber requires more heating to effect its consolidation, and behaves most capriciously when being cured.

Rubber which has been insufficiently ground or worked will invariably give a much lower specific inductive capacity than rubber which has been over-worked. One very serious result, arising from under-worked rubber compounds is that, after a short time, the core will show a tendency in its coatings to separate, or peel away from each other easily. I was told by a gentleman, about six months ago, who had charge of some repairing on the cable which was being made when this was discovered, that there was no difficulty in detaching the coatings from each other in mile lengths if it was required. Properly worked compounds of india-rubber when consolidated will, after the lapse of some years, show a slight sign of this tendency to peeling between the coatings, but even then with difficulty.

About three years ago I was unable to account for a great falling off in the insulation resistance of a cable which to all appearance was excellently manufactured. The resistance during the manufacture into cable had fallen from 27,000 millions, to 10,000 millions, and before laying was slightly under 4,000 millions of B.A. units. This cable was laid and behaved so perfectly that it gave over 80,000 millions at the end of half-hour's electrification with reversed currents, showing the absolute freedom from any local defect. The inner layers of the rubber in contact with the conductor showed a slight tendency to soften, but was not sufficiently so to account for so great a fall in the insulation.

Before laying this cable, I carefully tested it with 500 cells, and obtained most satisfactory results, with the zinc pole of the battery to the cable for half-an-hour. The reversal was made in the usual way, but was not followed with that uniform fall in the deflection, and at the end of the tenth minute gave unmistakeable signs of a fault, which was localised a few hours afterwards as being about 14 yards from one of the ends. After its removal the resistance rose to what it was before leaving London.

A piece of spare cable which was left in the ship was subsequently examined, and it was found that the two compounded rubber coatings could be most easily detached from each other.

Two or three other kinds of core were examined in the same way, and one of them in particular was alarmingly defective in this respect. It enabled us, however, to account for the low insulation of the cables.

I am the more surprised at this, as in the earlier days of testing, the examination was so rigid, and the manufacture so perfect, that I devised a test which enabled us to localise any fault due to the non-consolidation of the coatings. I found by this method that the want of uniformity in the insulation of india-rubber was due entirely to imperfect consolidating.

For the manufacture of india-rubber wires, the best Pará rubber is only employed. The bottles are first carefully examined, and the very finest quality is selected. It is then well washed and dried with a moderate heat and seclusion from actinic light as far as practicable.

When properly washed, it should yield but a very small quantity of soluble matter capable of deoxidising a solution of permanganate of potash. In this case it does not become mouldy on the surface. It should not show the slightest indication of nitrogenous matter; this I find can be easily accomplished when it is washed thoroughly with ordinarily pure water. I believe the use of water contaminated with organic impurities cannot be looked upon as harmless, either with india-rubber or gutta-percha.

The rubber, when thoroughly dried, is masticated generally. I am confident that this process has not been hitherto as carefully attended to as it deserves. The rubber should be as perfectly masticated as if for the production of fine sheet rubber. This may probably tend to make the rubber weaker for lapping, but there are many advantages in its favour, over a harsh and curly looking rubber, that no manufacturer ought to overlook. It is well known that imperfectly worked india-rubber is liable to very embarrassing changes under the vulcanising process. It is not so readily affected by sulphur, and requires more heating to bring about its consolidation.

Where india-rubber has shown a tendency to decompose in the inner portion of a core, I believe imperfect mastication is the principal cause. Excessive mastication is regarded as inducing decomposition, still I have never seen a case where properly masticated rubber has liquefied after being heated under a compound containing sulphur.

The yield of ash from raw and washed rubber varies. I have recently obtained the following results:

	Raw. Per cent.	Washed. Per cent.
Pará bottle*	·13 to ·19	·26
Ceará*	5·49	1·64
Negrohead*	·95	·83
Massaranduba	·33	

From the massaranduba rubber, unwashed, the yield of ash is ·327 per cent., Pará rubber, free from impurities, gives 5·485 per cent.

Certain metals when placed in contact with vulcanised rubber are capable of abstracting a portion of its sulphur, more particularly when heated. With rubber containing a small proportion of sulphur, this is so marked, that nitric acid of a specific gravity, 1·420 rapidly effects it when cold. It becomes thoroughly rotten and loses a great deal of its elasticity. This will help to explain the decomposition of the inner layers of an india-rubber covered wire.

A few years ago I removed several faults from some core which, when first tested, was excellent in every respect. The faults were invisible, and their position could be ascertained only by drawing sparks through these holes. This was very tedious, and led to no result. An induction coil was applied which immediately enlarged the fault, but so disguised it that nothing could be ascertained as to its nature. Several instances occurred when three or four holes were simultaneously developed on the application of the coil current, these results were very singular, the holes invariably appeared in a spiral direction, and on careful examination were all found to proceed from portions of the rubber immediately in contact with the same wire of the strand conductor. In every case the tinned surface of the conductor was eaten away, and the copper itself strongly attacked. I never met with any

* Well freed from adhering impurities, the purest and cleanest portions being selected.

similar faults over a wire where no action was visible. I am, therefore, disposed to think that the great want of permanence in the inner layers of an india-rubber covered wire is due to the devulcanising action of certain metals, and not to oxidation.

Defective joints, which at one time were considered an impossibility, were shown by my test to be by no means an unusual thing. No matter what the nature of the material may be, it is indispensable to secure absolute adhesion between its several coatings; and whilst by vulcanising or heating we obtain this, it must not be forgotten that imperfect grinding, or weighting with pigments, will most effectually prevent it, and that imperfectly dried india-rubber is equally to be guarded against.

Of all the materials incorporated with india-rubber for the purposes of vulcanising, I believe the sulphide of lead, which is technically known as "hypo," is the best, and if made of uniform strength, is the most reliable substance I have seen. It is of itself a very good insulator, and becomes highly electrical when dry if slightly touched. India-rubber vulcanised with it does not show that efflorescent surface which is met with in the articles vulcanised with the ordinary sublimed sulphur. One manufacturer, who used this at one time very extensively, was obliged to abandon it on account of its variable strength of free sulphur. I have seen it used at one time having 20 per cent. and at others 12 per cent. of sulphur. There should be no difficulty in making this absolutely uniform. I cannot understand why this has been so thoroughly discarded, for I have seen wires insulated to an ordinary thickness with rubber compounded with it, which have surpassed in durability everything against which it was tried. For aërial work and torpedo cables it should behave satisfactorily, if we only bear in mind how a well-made waterproof coat will stand all kinds of weather. I remember speaking to the late Dr. Miller about this matter, and he showed me a waterproof coat, which he assured me had been in use for seven years. The coat looked in all respects sound and perfect. I examined a short piece of wire (tinned copper) coated with this kind of rubber some years ago; it was the behaviour and appearance of this wire which led me to form so favourable an opinion of "hypo." Rubber compounded with "hypo" does not blacken a tinned wire during the vulcanising process. Ordinary tinned copper wire contains a large proportion of lead, which, of course, readily shows any effect of sulphur. These facts lead to some very significant results as to the action of sulphur on the durability of vulcanised, or semi-vulcanised cores.

If a wire could be manufactured with perfect centrality of the conductor being ensured, with rubber compound with this substance, I have reason to believe that it would be found highly durable. The inductive capacity of this compounded rubber, when vulcanised, is about one-third higher than that of masticated rubber after heating to the same temperature, and its insulation resistance is fully one thousand times higher than gutta-percha of the same thickness. Its mechanical properties when compounded with French chalk, so as to yield a specific gravity of 1·20, is very satisfactory. The red sulphide of antimony, and the sulphides of arsenic containing free sulphur, have also been used, but with results which do not promise any marks of preference over the corresponding lead compound. It is curious, though perhaps to some extent we may have anticipated it, that different vulcanising pigments give different co-efficients for changes of temperature.

Whilst on this portion of the subject, a few words on sulphur may not be out of place. Precipitated sulphur is easibly soluble in its suitable menstrua, but sublimed sulphur behaves very differently, about 25 per cent. being absolutely insoluble. Now I can hardly conceive that this can be unimportant, for if the sulphur first dissolves as it were in the india-rubber at the proper temperature, it must prevent its uniform distribution or diffusion. The sulphur or such portions of it as are not taken up, simply crystallise on cooling, and not being in combination, is removed easily. I remember seeing some core stowed in tanks with concrete bottoms, which by the action of the sulphur was literally eaten into large holes. Water containing any quntity of iron will show an immense accumulation of its sulphide after a short time. No one can regard this abstraction of sulphur as of no moment; its exudation must of necessity bring about a highly porous condition of the rubber.

It must have forced itself upon the attention of any one who has dealt with this subject, that the same compounds, containing sulphur, are eminently more durable before being vulcanised than afterwards; in fact, I cannot recall an instance of such rubber decomposing in any way.

I made some experiments, a few years ago, on the effects of vulcanising on the inductive capacity, and I found that the same compounds, heated so as to produce vulcanisation, gave about 30 per cent. higher capacity than when not heated. There was a little difference produced by heating for different periods of time, the result being that the shorter and lower the heat the less effect was produced on the inductive capacity; beyond a certain amount of heating, no further effect was produced.

The heat given to a core to produce vulcanisation has a most remarkable effect on insulation; thus, by a prolongation of the process, the resistance of a core may be raised to almost an unlimited value. A core giving about 4,000 millions of units resistance per mile, when cured, or heated, for four hours, may be made to give from 15,000 to 20,000 millions if heated for six or seven hours. I have invariably found that this high degree of insulation is not so permanent as a resistanec of 6,000 or 7,000 millions, and a resistance much short of this, though more permanent than very high resistance, will be found to fall off after a short time. I should consider a resistance of 7,000 millions of units per mile, at the end of one minute's electrification, as indicating that the core has received a proper amount of heating.

It has been a general practice to reheat core for the purpose of raising its resistance; I do not believe that any manufacturer can regard this as a desirable proceeding; core which has been reheated rapidly loses its insulating properties, the inner layer of rubber quickly becomes soft and sticky, and this change cannot be prevented from going

on, even when kept under water. It is, however, much accelerated by alternate drying and wetting. Freezing the core will, as far as I have been able to examine this phenomenon, arrest it. It is rather remarkable that if such core is kept in water at not less than 40° Fah., it shows no greater nor less an amount of change than if kept in water at 100 or 120° Fah. If such a piece of core has been kept in water for a few weeks, and is exposed to the air only for a few hours, especially in a warm atmosphere, it will rapidly fall in insulation.

This fact cannot be too strongly impressed upon those who have charge of cables containing india-rubber cores. I heard of a case a few months ago, where some cable, which had been picked up after three years' use, showed a strong illustration of this fact; some of the core had fallen to 80 millions per mile, whilst other portions were over 16,000 millions per mile.

I picked up some core between Pará and Cayenne a few years ago, which, when laid, had a resistance of about 30,000 millions of units after five minutes electrification, but, though laid only for a few months, had fallen to 9,000 millions of units; some portions picked up from a depth of 120 fathoms were only 2,000 millions of units per mile when laid, but after two years its resistance was almost the same; now I am confident that two or three hours exposure to the dry air of a ship's hold, after the core itself had become dry, would have been sufficient to have brought its insulation too low to have ventured its relaying. About 25 miles of this core was kept on board for about 16 days, and after the removal of a fault was relaid. The core contained a small piece of bone, probably a serrature from the saw of a young saw-fish.

So important is it that this should be impressed upon the minds of those entrusted with the repairing of india-rubber cables, for I have heard it said repeatedly by men who profess to know the handling of rubber cables, that it is by no means necessary to keep them under water. This is decidedly the most treacherous piece of advice that has ever been given to telegraph engineers.

If by extra care a length of core has been made which will stand this treatment, and we were in possession of only one instance where it failed to sustain this quality, we should modify at once all assurance in the matter, for it is not at all necessary to keep cables quite dry.

There are times when the tanks on board ship must be emptied, but then, if india-rubber cables are so seriously affected, it will be safest not to relay on any portion, however high apparently its resistance, if kept dry for any time, until it has been most carefully tested for some days in water.

I have picked up several miles of india-rubber core, and I have never had to reject any portion from faults other than those for which the cable was picked up. I feel confident that none of this cable would have been relaid, had it not been kept under water. I have probably had more experience in the recovery and repairing of india-rubber cables, and with the exception of faults due to avoidable causes, I have seen nothing which would shake my confidence in india-rubber. I have been informed that gutta-percha cables, when picked up after a few years' immersion, have sometimes shown a similar behaviour.

It is well known that tar obtained from the destructive distillation of wood has the singular property of reducing considerably the insulation of gutta-percha. I discovered a few years ago that the same effect was produced upon vulcanised rubber wires, and that when they were immersed in the tar itself, the absorption of a portion of the tar was so rapid that its effect was visible within a very short time. There are few subjects more deserving the investigation of chemists than the interesting inquiry arising from this. Sulphur dissolves readily in warm Stockholm tar, and solidifies on cooling. A piece of insulated wire placed in the warm mixture and allowed to set with it exhibits a similar charge, so that we may infer that it is not due to the abstraction of sulphur from the core. Boiling the tar with soda or potash does not deprive it of this curious property. Whatever these substances may be they do not exist in the tar obtained from coal. This, therefore, narrows the inquiry. As water impregnated with tar has the same effect, I am disposed to think that it is produced by some of these proximate principles soluble in water. I have found that if a wire be coated with the mixture of Stockholm tar and gutta-percha, used to cement together the layers in a gutta-percha core, and over this a coating of india-rubber be applied, it reduces the insulation in precisely the same way when heated. A mixture produced by boiling oxide of zinc and tar together so as to yield a brittle mass when cold, appeared to exercise much less effect on india-rubber when heated in the same way. Whether the removal of these substances will interfere with the antiseptic properties of tar must be carefully taken into consideration.

Vulcanite.—The India-rubber, Gutta-percha, and Telegraph Works Company have brought this department of the manufacture to a very high state of perfection.

A few years ago ebonite or vulcanite insulators were extensively used for line work. I am inclined to think that the bad repute into which this material fell, was due to the practice of some manufacturers to varnish these insulators with a mixture of asphalte and naphtha, for I have found that a clean and smoothly turned insulator retains its insulatory qualities for a very long time.

Insulator supports or pins were formerly covered with vulcanite, but as the material did not adhere to the metal, it allowed moisture to creep in, and producing rust, caused the rupture of the vulcanite covering.

Sometime ago I tried an experiment of covering these bolts with an elastic form of vulcanised rubber, first cutting a thread on the bolt, so as to prevent the rubber from slipping, I managed to obtain a good and permanent degree of insulation, without the liability to crack from frosts, or the production of an acid film, due to the oxidation of the sulphur.

Battery cells and other parts of electrical apparatus are extensively manufactured from vulcanite.

Electricians were satisfied a short time ago with the insulation obtained by ivory or dry wood, and varnished glass, for the non-conducting portions of their apparatus. The employment of vulcanite in place of these was a necessity due entirely to the higher requirements brought about for dealing with india-rubber covered wires.

An elastic form of vulcanite, or some form which will bear bending without cracking, and which can be joined, is at present a desideratum. It is as perfect a non-absorbent of water as any material at present in use, and its mechanical qualities are decidedly favourable. A practicable form of this material for covering wires would be an immense boon to telegraphy.

Vulcanite, when made from the best Pará rubber and sulphur, should yield but an insignificant residuum on incineration, a larger quantity of residual matter may be taken as indicating the presence of an inferior rubber or imperfect cleansing, whilst any residuum exceeding one per cent. of the weight employed, may be look upon as foreign matter.

I am not aware of any electrical measurements being made to determine the resistance or capacity of vulcanite. Its resistance is, I believe, higher than glass. A Rhumkorff coil giving an eight inch spark fails to pierce a sheet of vulcanite one-twentieth of an inch thick; the same coil easily ruptures a sheet of masticated rubber one-sixteenth inch in thickness, or vulcanised rubber having the same thickness as the vulcanite, is easily penetrated as well as glass itself.

In testing insulators and covered bolts, I adopted the following method which was so satisfactory, that the average rejections did not exceed 6·7 per 1,000, the minimum being as low as ·7 per 1,000.

A watertight box, about four inches deep, had its cover perforated with 500 holes slightly larger than the bolts to be tested; the vulcanite portion was then well cleaned and well wetted by rubbing with the fingers to within a distance of half an inch from the uncovered portion of the bolt. They were allowed to remain in the water for about one hour previous to testing.

Two large Leyden jars were charged from an electrifying machine to a tension indicated on an electrometer of about 1,500 cells; a loose wire attached to the electrometer and jars was moved from one bolt to another, whilst the instrument was carefully watched. A defective insulator could be readily discovered, and weak places due to air holes or imperfect seams were rendered visible by the disruptive discharge. From 1,000 to 1,500 insulated bolts could be easily tested in a day by this means. The Leyden jars are re-charged as soon as the tension shown on the electrometer has fallen too low.

Cup insulators may be tested in the same way, by filling them to within a short distance of the top with water. The greasy nature of the surface renders it necessary to rub them with the wetted fingers thoroughly, so as to remove air bubbles which adhere most obstinately to the roughened portions of the surface. Mr. Gray has enabled me to lay before you some specimens of the Silvertown manufacture, which will enable you to see to what extent this substance is employed in electrical apparatus and telegraph instruments. The more recent improvements in telegraphy require that our signalling apparatus should have such perfect insulating properties, which at one time could not have been obtained by electricians.

It is impossible to over-estimate the great advantage which ebonite has contributed towards the development of even pure electrical research. Without this substance many of the measurements which are daily made by the practical electrician could never be satisfactorily made. This can be understood if you imagine the cover of a megohm, or other high resistance, being made of wood, which would act as a bridge across the resistance, and from its hygroscopic quality be liable to great changes.

I regret that the length of this paper excludes my dealing with some other interesting properties of india-rubber which, perhaps not quite pertinent to the matter in hand, have, nevertheless, contributed facts of importance to the chemical and physical history of india-rubber.

The causes and conditions leading to the deterioration of india-rubber, the permeation and absorption of gases by this substance, are subjects of important bearing, and although much has been written on the decay of india-rubber, it is a subject which is far from being satisfactorily explained.

The commercial bearing of the question as to the durability of india-rubber wires is of such importance that I believe the Council of this Society could fully rely on the co-operation of those interested in it to re-open its investigation, and this I would urge upon the following ground:—Firstly, our knowledge of the subject is enormously in advance of what it was when her Majesty's Government instituted the inquiry in 1861; secondly, that no practical benefit has resulted from that inquiry, since the deductions drawn as to the failure of india-rubber have not been sufficiently confirmed; and, thirdly, that many failures have arisen mainly from the teachings contained in that report.

The following articles were kindly lent for exhibition:—

Anthracene, by Messrs. Bolton and Burt, Silvertown.
Mineral caoutchouc, by Professor Tennant, F.G.S.
Native ozokerite, by Professor Tennant, F.G.S.
Cannel coal, by Prof. Tennant, F.G.S.
Albertite, by Prof. Tennant, F.G.S.
Jet, by Prof. Tennant, F.G.S.
Torbane mineral, or bog-head coal, by Prof. Tennant, F.G.S.
Apps's patent induction coil, giving a 20-inch spark in air with five Grove's cells, platinum plates 6 in. by 3 in., by Mr. Apps, 433, Strand.
India-rubber and ozokerite, by F. Field, Esq., F.R.S.

Exhibited by the India-rubber, Gutta-percha, and Telegraph Works Company, Silvertown:—

Ebonite articles.
Insulators for aërial telegraphs.
Friction exploders for mining and torpedo purposes.
Battery cells, acid bottles, and jug.
Medical battery of 60 cells.
Disc for electrifying machine.
Torpedo connection, Mathesson's jointers.
Torpedo firing batteries.
Bobbins, tube, rod, and sheet for instruments.
Trough for amalgamating battery plates.
Telephone.
Mr. W. H. Preece's instrument for block signalling.
Resistance coils and testing keys.
Battery commutator and pillar terminals.
Pará rubber, raw, washed, masticated, and sheet.
Negrohead-rubber, raw and washed.
Ceará rubber, raw and washed.
Refined paraffin.

Refined ozokerite.
Purified ozokerite.
Naphthaline.
Torpedo cables manufactured for the English and American Governments.
Submarine cables, Havannah to Key West.
Braided torpedo core for military purposes.
British Government field service wire.

Exhibited by the author:—

Juice of the massaranduba or cow-tree.
Caoutchouc from the massaranduba or cow-tree.
Caoutchouc from the massaranduba or cow-tree vulcanised.
Caoutchouc from the massaranduba or cow-tree ebonite.
Thionolein or vulcanised oil.
Chloro-caoutchouc wires.
Bromo-caoutchouc wires.
Iodo-caoutchouc wires.

Exhibited by Hooper's Telegraph Company:—
Specimens of submarine cables manufactured and laid by them.

Exhibited by Mr. W. T. Henley:—
Patent telegraph core.
„ telegraph cable.

Exhibited by Mr. Leonard Wray:—
Wires insulated with Wray's compound.

DISCUSSION.

The Chairman, in proposing a vote of thanks to Mr. Warren for his paper and the valuable information it contained, said he was perfectly satisfied, in listening to it, that it was quite impossible for any stranger to these subjects to follow the great variety of detail it contained and to discuss it. He had no doubt it would have its value when printed and circulated, when those interested in it would have the privilege of carefully considering it and stating any points on which they differed from the author. One fact mentioned at the commencement was rather singular, viz., that there was scarcely a patent existing now for the use of india-rubber in a certain form. No one could doubt that a great number of patents had been taken out, and it was a singular thing that, in the course of a few years, whilst the consumption of india-rubber had increased enormously, scarcely an operative patent still existed. This was quite consistent with his views as to the effect of Patent-laws on discovery and invention. He believed they stimulated the bad inventor, very much to the injury of the good inventor, and so we had a multitude of patents thrown on the market, each one claiming a certain monopoly which encumbered the useful action of the more honest and better class of discoverers.

The vote of thanks having been carried unanimously,

Mr. Warren thanked the meeting for its approval.

Mr. J. F. Hooper said he should not like anybody to leave the room under the impression that cables laid by the Hooper Company had failed in any case from a defect in the cores, because that was not so. One of the earliest was the Persian Gulf cable, which was working perfectly at the present time; that was followed by the Anglo-Danish, which remained perfect; the same with the Anglo-Norwegian, and the Baltic. The China cable also remained in an excellent condition. He was assured by the electrician on the station a few months ago that those cables were as perfect as the day they were laid. The Western Brazilian Company, whose cables were laid by the Hooper Company, reported that there was no failure in the core, but in the sheathing; and from the Cuba Company they had a report that that was the finest cable ever made, and that it remained as perfect as the day it was laid.

MISCELLANEOUS.

THE TRADE IN BOXWOOD.

It appears that, in consequence of the continued increased cost of boxwood and its rapid decrease in quality, one of the principal importers of this and other hard woods into this country has succeeded in introducing two American woods to be used instead of box in the manufacture of shuttles, a purpose for which immense quantities of boxwood have hitherto been used. The woods so substituted are those of the cornel and persimmon. The first is apparently the *cornus florida*, a deciduous tree, about 30 ft. high, growing abundantly in woods in various parts of North America. The wood, though of small size, is hard, heavy, and close-grained, and is used chiefly in America for the handles of tools and for shuttle-making, and, when properly seasoned, is much superior to Persian boxwood. The same may be said of the persimmon (*diospyros virginiana*), a tree belonging to the ebony family, a native of the United States, where it grows to a height of from 50 ft. to 60 ft., and a diameter of a foot or 18 in. The heart-wood is of a dark brown colour and very hard. The trunk is covered with a very thick, hard, and rugged bark. One great point to be particularly remembered in the preparation of these woods for shuttle-making, is the very gradual drying by artificial means; this is more particularly recommended in the case of the cornel, undue haste in seasoning, it is said, having in some cases created a prejudice against the wood. As an illustration to some extent of the effects of the war, it may be stated that while in 1876 over 10,000 tons of boxwood were imported, the year just passed shows a return of only between 4,000 and 5,000 tons. A large proportion of this wood is the produce of the forests on the Caspian Sea. Though the supply from the Black Sea provinces has for some years past been decreasing, it is well-known that untouched forests of the wood exist in Russian territory, and it is hoped and expected that at the close of the present disastrous war these forests may be opened up, so that we may get abundant supplies of good wood for some time to come.

TANNING MATERIALS OF SOUTH AMERICA.

By Professor Max Siewert.

The tanning of heavy leather is one of the principal occupations of the northern provinces of the Argentine Republic. This country struggles under difficulties unknown in Europe, on account of the climate, which frequently causes the putrefaction of the skins during the process of tanning. It is therefore necessary to abridge as much as possible the duration of the operation. No rational method is followed in the manufacture, which is entirely empirical as yet. The tanners of the Old World prefer to employ the bark of the oak, which, although it does not possess a large quantity of tannin, produces an excellent article when the operation has been well conducted.

But the oak is not indigenous here, and has not yet been imported. The carob tree (Spanish algarrobo), which might be called the oak of the country, from its

slow growth and general aspect, unfortunately does not possess a bark rich in tannin.

Nevertheless, we have the cebil in two varieties—the red and the white—forming in the provinces of Tucuman, Salta, and Jujui, immense forests, which cover the mountain slopes to a considerable height. The bark of the red cebil contains more tannin than that of the oak, but it has the unsuitable property of giving a characteristic red colour to the hides, which, above all, appears when the tanning is completed and drying commences. This disadvantage having made it desirable to find a tanning material which will give the customary appearance to the skins, all the trees of our flora have been submitted to chemical analysis. I have separately investigated the wood, bark, and leaves, and the subjoined table gives an adequate idea of their tannic importance. The figures speak for themselves, but I will add such descriptive and general information on them as seems necessary.

Red Cebil (*Acacia Cebil*, Gries).—Experience, as well as chemical analysis, teaches us that the mature tree produces the greatest quantity of tannin, and that when the bark of old trees is used, the exterior layers, which are in general the hardest, should be rejected. I cannot affirm from my investigations that the trees of the plains contain more tannin than those of the mountains. The analyses not giving one constant result, I have been led to believe that the differences which have been frequently met with are all individual, and independent of the composition of the soil.

Experiments, the object of which was to isolate the tannin combined with the lime of the bark by boiling this with carbonate of soda, gave 1 per cent. of increase. The quantity of carbonate of soda was calculated from the weight of lime contained in the ash. It is remarkable that tho wood holds no trace of tannin, whilst the leaves generally give one-half the quantity found in the bark.

White Cebil.—This tree is distinguished from the red species by its leaves, which are more finely feathered, and by the facility with which its bark dries and ceases to take part in the circulation of the tree. It therefore results that the tannic acid is very rapidly decomposed in the exterior of the bark, and becomes oxidised or else withdraws to the interior, according as the bark dries. The proportion of tannic acid contained in the exterior and interior parts of the bark is as one to ten.

The young trees of the two species of cebil contain almost the same quantity of tannin; their wood contains a little, and the quantity in the leaves is somewhat superior to the half of that found in the bark of good quality.

White Quebracho (*Aspidosperma Quebracho*).—The trees which bear this name in the province of Cordoba do not belong to the same species as the white quebracho of Salta. I do not believe that the climate could cause a variety of this tree; in my opinion they are different species. The leaves of the quebracho of Cordoba are armed at their extremities with small thorns, which the species of Salta does not possess. The form and size of the leaves are alike, although those of the northern province are thicker. The aspect of the trees is also the same, although the quantity of tannin is very different.

The white quebracho of Salta is very similar to the German oak, and little inferior to the red cebil, whilst its leaves are one of the richest tanning substances in all the Republic, since they contain 27·5 per cent. Moreover, the tannic solution of the bark, as well as that of the leaves, is almost colourless; the red colour imparted to the hide may, therefore, be prevented, by operating with a mixture of the cebil and the white quebracho.

Espinillo (*Aacia Cavenia*).—This tree is more disseminated in the country than the algarrobo. It attains a greater or less height, according to the nature of the soil, but never exceeds twelve feet. It is recognised by its tender and finely feathered leaves and numerous thorns and fruit. The wood and leaves contain but little tannin (0·56 and 0·93 respectively); the bark (5·84), even if it contained more, it would not serve for tannin, because it is too thin and too difficult to separate from the trunk. The fruit, on the contrary, is rich in tannin, and although the seeds contain a very small quantity (12·03), the husks or shells contain 33·2 of pure tannin.

Algarrobo, black and white (*Prosopis Algarrobo*).—These two magnificent representatives of the Mimosa family thoroughly overspread our country. Unfortunately, in the populated districts they will soon disappear, on account of their slow growth, the small care taken of them, and the complete want of new plantations. The wood of the algarrobo is of extraordinary strength, therefore it is employed for all purposes.

It is not known why the designations, black and white, have been given to the two species. The flowers of both are white; the leaves of the black algarrobo are more finely feathered, and its fruit spotted with black and red is a little longer and narrower than that of the species called white, whose wood is dark brown, whilst that of the species called black is much lighter in colour and almost white in the young trees.

When the aged white algarrobo, with a trunk of more than a foot in diameter, is cut, a black and viscous liquid, bitter to the taste, escapes from the vessels nearest the bark; it contains much tannic acid.

The leaves, the bark, and the wood of the two species of algarrobo are equally poor in tannin; they are therefore of no interest to tanners. Their economic importance is however great, not only on account of their magnificent timber, but also for the fruit, which is an excellent food for domestic animals and even for man. A glance at the following analysis will prove this assertion:—

	Fruit of Black Algarrobo.	Fruit of White Algarrobo.
Water	16·26	10·84
Fat	0·26	0·43
Sugar	37·63	25·21
Starch	11·24	16·71
Protein	7·37	10·25
Cellulose	11·79	
Organic acids, pectin and non-nitrogenous nutritive substances	14·20	23·31
Ash	1·25	2·03
	100·	100·

The sugar in the fruit is identical with that contained in the grape and the apple, consequently, it is very fermentable, therefore the country people make an alcoholic sparkling drink from the fruit after macerating it in water, which they call aloja. That of the black algarrobo is preferred for this purpose, and the fermentation is caused by the protein substances which it contains. Here s the composition of the ashes of these fruits:—

	Black Algarrobo.	White Algarrobo.
Silicate of lime	2·70	—
Silicate of potash	—	5·84
Sulphate of lime	4·23	6·82
Phosphate of lime	26·20	24·92
,, magnesia	—	8·70
Carbonate of lime	5·14	—
,, magnesia	9·30	2·73
,, potash	7·11	31·05
Chlorate of potash	44·99	19·50
Oxide of iron	0·33	0·44
	100·	100·

The ashes, entirely destitute of soda, manifest such a large quantity of the salts of potash and of the phosphates, as to prove that this fruit is clearly of great importance as food. In several districts of the country

it is collected by the population, and forms their principal nourishment during the winter.

The algarrobillo, the wild walnut, the tipa, the coco or cochuchu (*Xanthoxylum Coco*), the tala (*Celtis Tala*), the lapacho (*Tecoma asper*, Gries.) the chanar (*Gourliaca decorticans*) and the cedar, are only of secondary importance to the tanner. We will make special mention, however, of the lecheron and the molles.

Lecheron.—In its leaves, its height, and its branches, this tree bears an external resemblance to the willow of Europe, and, like it, prefers a humid or marshy soil.

Its name, derived from *leche* (Spanish for milk), is due to its property, when a leaf or branch is cut or broken, on exuding a species of white sap, similar to the milky juice of the euphorbia. The leaves contain but one-third part of the tannic acid of the bark, and the wood is entirely destitute of it. Although the bark only contains 10 per cent. of tannin, it merits attention from its freedom from colour. The lecheron, moreover, has the advantage of being widely disseminated, and it grows much more rapidly than the cebil.

Molles.—In this country a number of trees and plants are designated by this name, although they bear no resemblance to each other, either in appearance of leaves, flowers, or fruit, and in reality belong to different families.

To distinguish them, a qualifying term is added to the generic name, such as molle for drinking, molle for tanning, molle for dyeing, &c. The "molle a biber," literally good for drinking (*Lithrœa Gilliesii*), is a handsome tree, found in the mountainous regions, which is utilised in different ways. The sweet and aromatic fruit is employed, as also an infusion of its leaves, in the manufacture of a refreshing drink, slightly alcoholic, a species of "aloja." The leaves contain 0·25 of colourless tannin: infused in water they serve as a black dye, and also to prepare a species of ink. Molle for dyeing and tanning is a species of *Duvana*. This variety contains more tannin than the preceding, and is used both for dyeing and for tanning. For this purpose the fruit is gathered before its maturity, when it is no larger than a grain of vetch.

The sprouts of a year old, despoiled of their leaves and fruit, do not contain more than 4·6 per cent. of tannic acid, whilst the leaves and fruit contain from 19·2 to 20. This variety of the tree does not exceed the height of twelve feet, and its leaves are very small. It is, therefore, difficult to procure large quantities; nevertheless, were the inhabitants to take the trouble to pick the leaves and the fruit from the dried branches, something could be made out of this rich tanning substance, especially in view of the fact that it is almost colourless.—*Journal of Applied Science.*

GENERAL NOTES.

The Influence of Vibration on Steel.—Hitherto it has almost invariably been assumed that the softer a bar of steel was the more likely was it to endure strains and shocks causing vibration. The *Engineer* notes some recent investigations carried out in the United States by Mr. W. Metcalf, of the Crescent Steel Works, Pittsburgh, which appear to show that popular opinion is wrong, and that the hard steel suffer less from vibration than the soft steels. Mr. Metcalf's attention was first called to the matter by the constant breakage of steam hammer piston rods. These, made of ordinary steel, lasted but six months, an iron rod breaking in half that time. Then lower and lower steels were tried, and broke in about five months. An accident caused the hurried use of a rod made of comparatively high steel; it was assumed that it would not last more than a week or two, but it actually held out for more than two years. Subsequently a lot of small steel connecting rods were tested in a special machine. The test required was that a machine should run four and a-half hours, at a rate of 1,200 revolutions per minute, unloaded, before the connecting rod broke. These rods were unforged in the middle, and consisted of a piece of straight round bar with a head welded on each end, the middle of the piece being left as it came from the rolls. This explanation is necessary in order that it may be understood that no accident of forging affected the results. "The mode of rupture was," says Mr. Metcalf, "as a rule, the same in all cases; the rod heated at the middle, where the vibrations met, as they were imparted by rotary motion at one end and by reciprocating motion at the other, and by alternating strains of compression and extension. In some cases the rod became slightly red hot at the middle before rupture. After heating, the next thing observed was the raising or loosening of the surface scale of the middle. Soon after this rupture began, first at the surface and gradually extending to the centre, until finally the rupture took place. The breaking was gradual in every case, no piece breaking suddenly, even of the highest steel. The first trial was with ·53 carbon steel: mean time of six trials, two hours nine and one-eighth minutes. Second trial, ·65 carbon steel: mean time of six trials, two hours fifty-seven and a half minutes. Third trial, ·85 carbon steel: mean time of three trials, nine hours forty-five minutes, or more than double the requirements. This was satisfactory, and the trials were stopped." A set of twelve connecting rods, made from special ingots, was then prepared, and tested specially, with results showing that the maximum of strength to resist vibration was not found among the ductile steels. Mr. Metcalf gives some other data concerning the performance of steel suspension rods in a bridge which corroborate his views, which are practically novel.

NOTICES.

PROCEEDINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at eight o'clock. The following arrangements have been made:—

JANUARY 23.—"The Art of Marbling." By C. W. WOOLNOUGH, Esq.

JANUARY 30.—"The Art Manufactures of Japan." By CHRISTOPHER DRESSER, Esq., Ph.D. Sir RUTHERFORD ALCOCK, K.C.B., F.R.G.S., will preside.

FEBRUARY 6.—"Higher Commercial Education." By JOHN YEATS, Esq., LL.D.

FEBRUARY 13.—"The Systems of Cremation in Use upon the Continent." By W. EASSIE, Esq.

FEBRUARY 20.—"The Steam Tramways of Paris," by J. L. HADDAN, Esq., M.I.C.E.

FEBRUARY 27.—"The Past, the Present, and the Future of the River Thames." By J. B. REDMAN, Esq.

MARCH 6.—"On an Electric Lamp-lighting System." By ST. GEORGE LANE FOX, Esq.

MARCH 13.—"The Type-writer." By R. BRUDENELL CARTER, Esq., Member of the Council of the Society.

MARCH 20.—"Emery and Corundum Wheels for Grinding and Surfacing Metals and other Materials." By A. H. BATEMAN, Esq., F.C.S.

MARCH 27.—"Musical Education at Home and Abroad." By ALAN S. COLE, Esq.

AFRICAN SECTION.

Tuesday evenings, at eight o'clock. The following arrangements have been made:—

FEBRUARY 19.—"Egyptian Obelisks and their Relation to Chronology and Art." By BASIL H. COOPER, Esq., B.A. Admiral Sir ERASMUS OMMANNEY, C.B., F.R.S., will preside.

Indian Section.

Friday evenings at eight o'clock. The following arrangements have been made:—

February 1.—"The Destruction of Life in India by Wild Animals." By Sir Joseph Fayrer, M.D., K.C.S.I. Sir George Campbell, M.P., K.C.S.I., D.C.L., will preside.

February 22.—"Irrigation Regarded as a Preventive of Indian Famine." By W. T. Thornton, Esq., C.B.

March 15.—"The Colonisation of Hill Districts in India." By Lieut.-General McMurdo, C.B.

March 29.—"The Depreciation of the Value of Silver, with Especial Reference to the Exchange between India and England, and Suggestions for a Remedy." By Col. J. Smith, R.E., late superintendent of Madras Mint.

Chemical Section.

Thursday evening at eight o'clock. The following arrangements have been made:—

February 14.—"Recent Improvements in the Metallurgy of Nickel." By A. H. Allen, Esq., F.C.S.

February 28.—"The Chemistry of Infection, or the Germ Theory of Disease from a Chemical point of View." By C. T. Kingzett, Esq., F.C.S.

Cantor Lectures.

Monday Evenings, at Eight o'clock. First Course, on "The Manufacture of Paper," Six Lectures by William Arnot, Esq., F.C.S.

The Fifth Lecture was delivered on the 14th inst., and will be published in the next number of the *Journal.*

Lecture VI.—January 21st.

The various classes of Paper; characteristic differences. The determination of the ash or loading. Water supply. General arrangement and construction of the mill.

Additional Lectures.

A Course of Three Lectures, on "Explosions in Coal Mines," will be delivered by T. Wills, Esq., F.C.S., on the three following Monday evenings, at Eight o'clock, January 28th, February 4th, and February 11th.

Lecture I.—January 28th.

The nature of the Coal Measures. Mining for coal. Ventilation of mines. Composition of coal. Occurrence of fire-damp or marsh gas in mines. Nature and properties of fire-damp. Dangers connected with its presence.

Lecture II.—February 4th.

After-damp or choke-damp. Methods adopted to allow of safe working in fiery mines. Various appliances for lighting mines. The nature of the safety lamp. Different forms of this lamp.

Lecture III.—February 11th.

Connection of the variations of atmospheric pressure with explosions in coal mines. Dangers attending blasting operations in coal mines. Action of coal-dust in certain classes of explosions. The use of the safety lamp as an indicator of the presence of fire-damp, also as a means for its quantitative estimation.

In the notice of Prof. Barff's Juvenile Lecture last week, the name of the demonstrator was given as J. H. Pearse. It should have been J. H. Paul.

MEETINGS FOR THE ENSUING WEEK.

Mon.....SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. William Arnot, "The Manufacture of Paper." (Lecture VI.)
Royal United Service Institution, Whitehall-yard, 8½ p.m. Lieut.-Col. C. E. Howard-Vincent, "The Requirements of the Volunteer Force."
British Architects, 9, Conduit-street, W., 8 p.m. Mr. E. I'Anson, "The Architecture of Norway."
Medical, 11, Chandos-street, W., 8.30 p.m. (Lettsomian Lectures.) Mr. F. Mason, "The Surgery of the Face, Mouth, and Throat." (Lecture II.)
Asiatic, 22, Albemarle-street, W., 3 p.m.
Victoria Institute, 10, Adelphi-terrace, W.C., 8 p.m. Prof. Lias, "Modern Culture."
London Institution, Finsbury-circus, E.C., 5 p.m. Prof. Armstrong, "Colours from Coal."

Tues....Royal United Service Institution, Whitehall-yard, S.W., 8½ p.m. Adjourned Discussion on Colonel Howard-Vincent's Paper, "The Requirements of the Volunteer Force."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Garrod, "The Photo-plasmic Theory of Life and its bearing on Physiology." (Lecture I.)
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Dr. Paget Higgs and Mr. Brittle, "Some Recent Improvements in Dynamo-Electric Apparatus."
Anthropological Institute, 4, St. Martin's-place, W.C., 8 p.m. 1. Rev. William Y. Turner, "The Ethnology of the Motu, New Guinea." 2. Mr. John Evans, "A Discovery of Palæolithic Implements in the Valley of the Axe, Devon."
Royal Colonial, 15, Strand, W.C., 8 p.m. Sir Daniel Cooper, "A Sketch of New South Wales."

Wed.....SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. C. W. Woolnough, "The Art of Marbling."
Geological, Burlington-house, W., 8 p.m. 1. Prof. J. W. Judd, "The Secondary Rocks of Scotland.—Part III. The Strata of the Western Coast and Islands." 2. Mr. A. B. Wynne, "Notes on the Physical Geology of the Upper Punjàb, India." 3. Mr. R. Daintree, "Notes on Certain Modes of Occurrence of Gold in Australia."
Roya Society of Literature, 4, St. Martin's-place, W.C. 8 p.m. Mr. C. H. E. Carmichael, "Continental Notes on the Wax Tablets of Pompeii."
Royal United Service Institution, Whitehall-yard, S.W. 8½ p.m. Resumed Discussion on Col. Howard-Vincent's Paper, "The Requirements of the Volunteer Force."
Royal, Burlington House, W., 8½ p.m.
Antiquaries, Burlington House, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 7 p.m. Prof. Sidney Colvin, "Olympia and Ancient Greek Athletics."
Society for the Encouragement of the Fine Arts, 9, Conduit-street, W., 8 p.m. Annual General Meeting.
South London Photographic (at the House of the Society of Arts), 8 p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "Chemistry of the Organic World." (Lecture I.)
Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.

Fri.......Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Prof. Huxley, "William Harvey."
Quekett Microscopical Club, University College, W.C., 8 p.m. Mr. T. Charters White, "Insect Dissection."
Clinical, 53, Berners-street, W., 8½ p.m.

Sat......Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Mr. R Bosworth Smith, "Carthage and the Cathagenians."

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,314. VOL. XXVI.

FRIDAY, JANUARY 25, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

UNIVERSAL CATALOGUE OF PRINTED BOOKS.

His Royal Highness the Prince of Wales, K.G., President of the Society of Arts, has referred to the Council the subject of the cost of producing a universal catalogue of all books printed in the United Kingdom up to the year 1600.

This idea originated with Mr. Dilke (grandfather of the present baronet), who published it in the *Athenæum* of the 11th May, 1850. It was brought to the notice of the Society of Arts as far back as December, 1852, and two years ago, just before the Prince of Wales started for India, a printed specimen of such a catalogue was submitted to his Royal Highness.

The Council of the Society, being desirous of collecting information to enable them to report to their President, will feel greatly obliged if librarians, publishers, and printers, will kindly give replies to the following questions, and return them, answered, to the Secretary on or before 15th February, 1878.

QUESTIONS.

1. As it is proposed to issue the catalogue in sections, do you approve of dividing the catalogue into periods, say, of fifty years? If not, please say what other periods you recommend.

2. Do you approve of the size of the proposed page and type?* If not, what do you suggest?

3. Would you be willing to attend a meeting of the Council, and give explanations of your views generally on the subject?

* A specimen of the proposed catalogue may be seen at the Society of Arts, Adelphi, between the hours of 10 and 4, or a copy will be sent for inspection, to be returned.

CANTOR LECTURES.

THE TECHNOLOGY OF THE PAPER TRADE.

By William Arnot, F.C.S., Edinburgh.

LECTURE V.—DELIVERED JANUARY 14, 1878.

The chemicals used in the paper mill; their nature, economical use, and methods of valuation. The recovery and re-use of soda as an economical process, and in its sanitary bearings. The disposal of washing and machine waters, so as to minimise the pollution of streams.

Almost as important as the introduction of machinery has been the application of chemicals in the manufacture of paper. We have already seen what important parts soda, and chlorine, and alumina play in the various stages of the process, and now it falls to us to consider the nature of the commercial chemicals containing these active agents.

First in point of time, if not also in importance, we have caustic soda. This agent, as now used, was unknown as a commercial article until little more than a quarter of a century ago. It is now manufactured in very large quantities, and is used extensively in soap-making, bleaching, paper-making, and—in smaller proportions—in many other trades. We shall first look at the chemical structure of this substance, and of the salts formed by its union with carbonic acid, which are also useful to the paper-maker. Then we shall glance, in succession, at the commercial methods of producing these agents; at their employment in the paper mill; the methods of testing or valuing them; and the methods of recovering them after they have done their work, and of re-using them in the mill.

Caustic soda consists essentially of the metal sodium combined with oxygen and hydrogen. When sodium is burned in oxygen gas, two equivalents of the metal combine with one of the gas, and sodium oxide (Na_2O) is the result. This substance has a powerful affinity for water, with which it combines, forming sodium hydrate ($NaHO$). The reaction may be symbolised thus:—$Na_2O + H_2O = 2\ NaHO$. This agent, contaminated with varying proportions of soda and other salts, is known in the arts as "caustic," or caustic soda. As its name implies, it is highly caustic, or burning in its nature. It is so very deliquescent that, if left exposed in the air for some little time, it will become liquefied by the water it absorbs.

For all substances of an acid nature caustic soda has a strong affinity, and it is in virtue of this property that it is so eminently serviceable in the treatment of raw fibre-yielding vegetable substances. When exposed to the air it not only absorbs moisture, as already stated, but also carbonic acid, carbonate of soda being the result. The exact composition of this substance in the anhydrous condition is Na_2CO_3. When this is formed from sodium hydrate, a molecule of water is involved in the reaction, thus—$2NaHO + CO_2 = Na_2CO_3 + H_2O$. Soda ash and soda crystals consist essentially of carbonate of soda, the former being anhydrous, and the latter combined with

seven equivalents of water of crystallisation. The soda recovered by incineration from the waste soda leys is also a carbonate, indeed a crude soda ash often quite as rich in available soda as ordinary commercial ash. The impurities are, however, generally of a more objectionable nature.

Common salt is the native sodium compound upon which the chemical manufacturer operates, to produce the numerous soda salts met with in commerce. Upon this he brings oil of vitriol or sulphuric acid to bear, with the result that it is split up into two, the chlorine going off with hydrogen as hydrochloric acid, which is in turn also split up that the chlorine may be got to make bleaching powder. The sodium takes the place of the hydrogen which has been eliminated from the sulphuric acid, and thus becomes the basis of a new chemical structure known as sulphate of soda or salt-cake. This substance is of no value to the paper-maker, but it is the first step towards producing what is really wanted.

The salt-cake is mixed with limestone and carbon or small coal, and heated to fusion in a reverberatory furnace, the practical result being the production of soluble soda—partly caustic, partly carbonated—and insoluble sulphides of calcium. Lixiviation dissolves out the valuable soda products, leaving the insoluble calcium and sulphur compounds to be disposed of as best the manufacturer can, so as to minimise the nuisance which must necessarily result from their gradual decomposition and the formation of soluble sulphides.

The soda solution may either be evaporated, and the product furnaced into soda ash, or it may be treated with caustic lime, and the caustic liquor concentrated and finally kept in a state of fusion at a red heat, until the impurities are so reduced in quantity that the product may test 60 or 70 per cent. of real soda (sodium oxide), as may be required. What is known as caustic soda ash, contains variable proportions of its soda in the caustic state, the bulk of it, however, being carbonated. Ordinary ash contains but little caustic, and the difference is produced by employing different methods of evaporating the crude liquor, and calcinating the product. Refined soda ash is just ordinary soda ash freed from colour and certain impurities by resolution, clarification, and evaporation, or by the treating of the finest of the crude liquors with small proportions of nitrate of soda, to oxidise the sulphides. It is not necessarily, or, indeed, usually, stronger than ordinary ash. Freedom from colour, sulphur, and mechanical impurities, are its characteristics. When a hot saturated solution of refined soda ash is allowed to cool, nearly pure carbonate of soda crystallises out, in combination with seven equivalents of water—the crystallised product being what is so well known as soda crystals.

The important part which caustic soda plays in the economy of the modern paper mill is now well understood. I have already adverted to its action upon grease, oils, gluten, resin, and silica, as well as upon cellulose itself, and need only further remark that while the agent is indispensable it is also expensive—amounting to about 10 per cent. of the value of the product—and this being so, it is important that it should be used in the most economical manner, consistent with effective work. That there is in this respect room for improvement in very many mills, there can be no doubt. I have seen much accomplished where the boiling arrangements had been previously considered perfect. It is sometimes found economical to purchase soda ash instead of caustic soda, dissolving it, and causticising the solution with quick lime. When the waste lime sludge can be readily got rid of, it is possible to make a profit of this; but at most mills it is a serious matter to get rid of the sludge, as well as the other refuse matters which so rapidly accumulate. For size making, soda crystals are no doubt very suitable, being the purest form in which soda can be purchased commercially. From experiments made under my own direction, however, I am convinced that an equally good size can be made with soda ash, provided only it be quite free from colour and mechanical impurities, and it should not be difficult to secure a supply meeting these conditions. The result of the use of ash as against crystals is a saving in the sizing charges.

Every paper-maker should know the strength of the chemicals he is using, and that not so much to satisfy himself as to the character of the goods which his merchants are sending to him—though this is not unimportant—but what is of more consequence, that he may be enabled to regulate their use in the mill so as to ensure uniform and satisfactory results. The determination of the soda in caustic, and in the various carbonated compounds, is one of the simplest of analytical processes. It would be a mistake, however, to suppose that even this simple operation can be done successfully and accurately without some manipulatory skill, and suitable and accurate weights and measures. First of all we must prepare a standard solution of sulphuric acid of such a strength that the contents of each division of the burette intended to be used will equal one grain of real soda. By operating upon 100 grains of the sample to be tested with such a solution, the divisions consumed will give the per-centage of soda direct. There is some trouble connected with the preparation of a solution of this description, and, unless the mill staff includes a trained chemist, it is better to secure a supply of accurately adjusted standard acid from a professional chemist. Professional jealousy need not prevent any analytical chemist supplying this, as the work to which it is to be applied is such as can only be done in the mill, if it is to be of the practical utility I have indicated.

In addition to the standard acid, a solution of litmus must be at hand, and in some cases it will be found advantageous to have a supply of litmus papers as well. With these tests prepared, the appliances required for the actual operation are few and simple. A balance and weights, the former capable of turning with one-tenth of a grain; a burette and stand—the burette graduated to indicate quarter per cents will be sufficient—a large porcelain basin, with a suitable tripod stand, and Bunsen burner, and a few glass stirring rods. Boiling water, from a clean kettle, will be quite suitable for dissolving the sample. The process may be conducted as follows:—The sample, which must, of course, be a fair representation of the drum or cask from which it is drawn, should, in the case of caustic soda, be quickly crushed into small fragments and returned to the stoppered bottle in

which it was collected. There is no need for grinding up the sample, for, if time is occupied doing this, moisture will be absorbed and the results vitiated. The contents of each drum are usually pretty uniform, and the crushing recommended will give the operator a sample quite fit to work upon. Samples of soda ash and soda crystals will, of course, be fairly representative of the casks from which they are drawn. One hundred grains of the prepared sample must be weighed out upon a watch glass, or slip of glazed paper, and transferred to a porcelain basin, with at least half a pint of boiling water. The watch glass is preferable for caustic soda, and the weighing in the case of that agent must be done expeditiously. While the sample is dissolving, the burette will be charged with the standard acid. To the soda solution a few drops of solution of litmus sufficient to colour it distinctly will be added. The acid will then be run into the blue soda liquor; at first and within reasonable limits this may be done rapidly, but towards the close of the operation the acid must be added cautiously and the solution kept well stirred. In the case of caustic, when the blue has distinctly changed into red, the operation may be considered completed, and the measures consumed read off the burette; as I have already indicated, this is without calculation the result required. When the soda in the sample is a carbonate, the blue colour of the litmus will be changed to pink before all the soda is neutralised, owing to a portion of the liberated carbonic acid remaining in solution; this must be eliminated by placing the basin over the Bunsen and boiling the solution. The blue colour will thus be restored, and more acid must be added, repeating the boiling from time to time, until the red colour becomes permanent. It is sometimes necessary to filter the soda solution before testing; this applies specially to recovered soda, and, although in a less degree, to soda ash.

In sampling soda, as in sampling everything else, great care must be taken to secure a fair average of the stock. Professional chemists, as well as buyers and sellers, are often much annoyed by the discrepancies in the results obtained on analyses, traceable alone to different samples having been supplied to the different analysts, under the assumption that they must be alike, while in reality they are often very different. This is especially the case with samples of recovered soda, and I cannot too strongly urge that in all cases where disputes are likely to arise between buyer and seller, samples should be most carefully drawn in duplicate, either mutually, or by an independent competent party.

When soda has done its work in the process of boiling, the spent alkaline liquors are highly charged with matters which, when allowed to flow into streams, produce an effect which is very offensive. This has led to the evaporation of these liquors, and it is satisfactory to know that in most cases the operation has not only greatly increased the purity of the streams, but has also proved remunerative to the mill-owners. That the process may be conducted profitably or otherwise, will depend upon the strength of the waste ley, the price of coal—taking quality into account—the efficiency of the apparatus employed, and the skill with which it is worked. There are many competitors in the field, each with the best recovery apparatus, occupying little or no room, costing little or nothing to erect, and recovering the soda in a high state of purity, at an infinitesimal cost, and, of course, free from the nuisance of smell. As I devote much attention to this branch of chemical engineering, I must be excused for not giving an opinion upon any of the competing systems. I will, instead, try to point out some of the features which a good recovery furnace should possess. It should be constructed of the very best fire-bricks, not too silicious in their nature, and bound very strongly with iron plates and binders. The evaporating pans should be constructed of what are known as "best" plates, and the workmanship should be quite equal to that of a first-class steam boiler. Both upper and under sides should be exposed to the action of the hot gases as they pass onwards from the furnace to the chimney. The structure, as a whole, should be neat and strong, well housed, and capable of being kept cleanly and worked easily. The furnace should be shallow, the fire bridge low, the hearth not too deep, the roof low, and the pans long and rather shallow. The draught should be capable of easy adjustment, and, in working, must be frequently altered. The quantity of soda recovered should be equal to from 70 to 75 per cent. of the soda used, and to secure this none of it must be drawn up the chimney, converted into slag, or run into the river. It should be possible to work the furnace with very little smell; but, in my travels, I have only seen one that completely prevented smell—a very expensive erection designed by a French engineer. It is an easy matter preventing smell in the recovery house, but the more objectionable smell from the chimney is not so readily overcome. All leys having an average strength of 5° T. and upward should be evaporated at least without loss; below that strength, it will require very good working to make both ends meet. That the boilings of most raw materials should be kept out of our rivers there can scarcely be two opinions. Not to speak of the offensive appearance which they are calculated to give the stream, both on account of their colour and their frothing quality, the water must be rendered quite unfit for any of its primary purposes. I am far from being in favour of harsh measures, and quite realise the importance of fostering rather than oppressing our manufactures; but, where it can be shown that a public good can be effected, not only without loss to the manufacturer, but at a positive gain, there is little reason why it should not be done. The paper-makers on the Esk, near Edinburgh, who were first driven to evaporate their liquors, had, no doubt, many difficulties to overcome; efficient apparatus was yet to be designed; and, in some cases, four entirely different sets of apparatus were erected before a reliable working system was obtained. This involved much loss, which no paper-maker resolving to recover his spent soda need now incur. Some of the earlier furnaces consumed as much as eight to ten tons of coal for every ton of soda recovered. Now, however, from one and a-half to two tons should be sufficient to recover a ton of 48 per cent. ash from esparto liquors.

Before the soda is withdrawn from the furnace,

the organic matter should be well burned off, so that the product may not smell offensively when exposed to the air. It should then be deposited on the recovery house floor in such a way that the carbon will be readily burned out without fusing the mass. The product should be spongy, friable, and easily dissolved. It is always more profitable to causticise and use up the recovered soda in the mill where it is produced then to pack and sell it. The causticising apparatus should, if possible, be so arranged as to avoid hoisting and pumping. It is seldom that the levels are such as to admit of both objects being attained, and in some cases neither of them are attainable. The agitating vessels should be capacious and well proportioned, provided with ample agitating and steaming power. A good size of pan is 6 ft. deep, by 7 ft. in diameter, and capable of taking a charge of 12 to 14 cwts. of soda. The soda is sometimes, and with advantage, dissolved in a separate vessel, and the liquor, free from sedimentary matters, introduced into the causticising pan. There is thus no risk of destroying the agitators with hard lumps of fused soda, or pieces of brick, which sometimes get into the soda heap. The lime required to causticise a ton of soda will vary from 9 to 15 cwts., depending upon its quality, the strength of the recovered soda, and whether it has been dissolved in clean water or coolings. It is scarcely possible to eliminate the carbonic acid entirely from solutions made with coolings, yet it is sometimes imperative that these be used for that purpose. The lime will, of course, be put into a cage hung over the side of the agitating vessel, and not into the vessel itself. From four to six hours steaming and agitating should be sufficient to causticise the soda as thoroughly as the condition of the solution will allow. After from two to four hours quiescence, the clear caustic liquor will be run off, and the lime sediment agitated for half an hour or so, with a further quantity of water, and again allowed to settle. The weak soda solution thus obtained will be added to the original strong liquor, and the lime washed into draining vessels, the drainings being used for dissolving the next batch of soda. It is very difficult to remove the last portions of the soda from the lime sediment, and there is, of course, a limit to the amount of water that can be used for that purpose. By a process of washing in the drainers, analogous to the process of claying sugars, most of the remaining soda liquor can be driven out or displaced by clean water. The causticised soda liquor will be measured into the boilers, the value of each inch in depth of the measuring cistern having been previously ascertained. There is always a certain loss of soda to be made up with fresh caustic or with causticised soda ash liquor, and it is better to use the new and recovered together in some definite proportion in each boiler, rather than to boil so much of the raw material with all fresh, and the remainder with all recovered soda. The strength of the recovered soda is thus kept uniform, and in every way better results are obtained.

The nature and valuation of bleaching powder must now receive our attention. The chemical composition of this substance is rather complex. If a sample of 35 per cent. powder be taken and agitated with water it will be found that about 85 per cent. has gone into solution, the remainder being insoluble. The soluble portion consists chiefly of hypochlorite of calcium represented by the formula $Ca\,Cl_2\,O_2$. This is the agent which, yielding up its chlorine, performs the very important function of bleaching the half-stuff prepared in the breaking engine. The remainder of the soluble matter is the inactive chloride of calcium, and sometimes also small quantities of chlorate of calcium. The insoluble portion consists of lime, 10 per cent.; carbonic acid, 4 per cent.; and silica, &c., 1 per cent.

I have already stated that the chlorine is held in very feeble union with the other elements of the hypochlorite; it may indeed be considered as an almost free agent, its action upon colouring matter being energetic, and the destruction of the colour complete and permanent.

The destructive effect of the agent may readily extend to the fibre itself if too strong a solution or too much heat be employed. The temperature in hot bleaching should not exceed 90° F., or the cellulose will be sure to suffer in weight, colour, and strength. The only physical feature of bleaching powder which it may be well to note is the readiness or otherwise with which the insoluble matters subside in the mixers, this being very much dependent upon the nature of the limestone or chalk used in the preparation of the powder.

The process by which bleaching powder is produced may be very briefly described. The lime, which is the basis of the structure, is simply calcined limestone or chalk slaked with a due proportion of water, and after thorough hydration screened or dressed so as to remove sand and other gritty impurities. This prepared lime, which is an impalpable powder, is spread upon the floor of a chamber constructed of stone or lead to a depth of six inches or so. The gaseous chlorine, the preparation of which I will refer to immediately, is delivered into the chamber, and is absorbed by the lime, the result of the combination being bleaching powder ready for packing into casks. There is a limit to the power of lime to take up chlorine, and in practice it is found difficult to get that portion of it which is in a condition available for bleaching much above 35 per cent., and at that standard it is usually sold in this country.

The chlorine gas is now almost entirely generated by Mr. Weldon's patent process, the result of the extensive adoption of which has been to increase the production and reduce the cost of bleaching powder. It will be remembered that the hydrochloric acid, produced by the decomposition of common salt in the manufacture of soda, was stated to be the source of the chlorine used in producing bleaching powder. This acid is decomposed when brought into contact with black oxide of manganese, one-half of the chlorine being liberated in the gaseous condition, the other combining with the manganese to form chloride of manganese. It used to be customary to discharge this agent into our streams and water-courses as a useless product, and the result of doing so seriously interfered with the purity of the water. By a very beautiful process, Mr. Weldon has succeeded in conferring a value upon this agent, which is the best guarantee of its being kept from again polluting our rivers. The spent manganese liquor is neutralised with

limestone or chalk, and allowed to clarify, when it is discharged into a deep malleable iron vessel called the oxidiser, and into this a certain quantity of milk of lime, sufficient to precipitate all the manganese and one-third more, is pumped; a strong blast of air is then blown through the mixture until the precipitated red oxide is oxidised into black oxide, or rather, as Mr. Weldon calls it, manganate of manganese. When this effect has been produced, the blast is stopped, and the contents of the oxidiser discharged into settling tanks, when the manganate subsides and chloride of calcium liquor comes to the top. The latter is run to waste, and the manganese mud, as it is called, is run into stone stills along with hydrochloric acid, when the same reaction as before takes place, and the same liquid is produced, to be treated again precisely as I have described. This round of changes goes on continually, small additions of fresh manganese being made from time to time, to compensate for the loss inevitable in this as in almost all manufacturing processes.

The valuation of bleaching powder involves more labour and manipulative skill than the testing of soda. The per-centage of available chlorine is what has to be determined; and there are several methods of doing this, but two are generally in use, and I shall describe both of them. The reaction in both processes is an oxidising one; in the one ferrous oxide is converted into ferric oxide, while in the other arsenite is converted into arsenate of soda. In the iron process, as it is called, 39·15 grains of pure sulphate of iron are dissolved in about four ounces of water and acidulated with a drop or two of dilute sulphuric acid. Two hundred grains of the sample to be tested are rubbed up with water in a large mortar, and the solution made up either to 10,000 grains, or to a litre, according as English or French measures are being used. A burette graduated into thousandths and decimals thereof of the whole volume of the solution prepared, is charged from the mortar with the aid of a porcelain ladle. From the burette the bleach liquor is delivered into the iron solution contained in a vessel of about 12 oz. capacity, until the iron is all changed into the ferric state. To ascertain precisely when this effect is produced, a little of the mixture is lifted on a glass stirring rod and dropped upon a solution of red prussiate of potash, which has been previously spotted over a white slab; on the two drops coming into contact, a blue or—as it approaches completion—green colouration will be the result so long as any of the iron exists in the ferrous state. When the iron is completely oxidised no such colouration will be produced. The iron used equals exactly five grains of chlorine, so that the calculation is a simple one. It is right to state that objection has been taken to this process, but I have not been able to discover wherein error is likely to arise in its execution more than in any other, unless, at one point where a slight loss—and with care it need be but very slight—occurs, owing to the liberation of chlorine in the gaseous state towards the close of the operation, resulting from the iron solution being acid. To ensure satisfactory results, that is, results within one-fifth per cent. of the truth, the following particulars must be attended to:—First. The iron must either be quite pure, or its value must be ascertained and allowed for. Second. The weights and measures, must agree among themselves; it matters little whether either of them have a precise value, so long as the smaller weights and divisions are *aliquot* parts of the larger. Third. A drop or two of acid is sufficient to add to the iron solution; more must be avoided. Fourth. Care must be taken to ensure the complete solution of the soluble part of the powder, and the sediment should be uniformly diffused through the liquor, by stirring with the ladle previous to charging the burette. Fifth. The burette should be filled, the level adjusted, and the testing started without loss of time, so that the sedimentary matter may not settle in the burette before the operation is completed; of course, the iron solution will be ready, and the slab spotted, before the burette is charged. Sixth. While the bleach liquor is being run into the iron solution, the latter should be kept well stirred, and towards the close of the operation the liquid should be run in in small, successive quantities, with frequent testing.

The arsenic process is conducted as follows:—A standard solution of arsenite of soda is prepared by dissolving 139·5 grains of pure arsenous anhydride, and 400 grains of pure crystallised carbonate of soda, in 6 or 8 oz. of water. This can be best effected by boiling and shaking for some time; when the desired effect has been produced, the solution is allowed to cool, and is then made up to 10,000 grains, or one litre. Ten grains, or 1 cc. of this solution is equivalent to 0·1 grain of chlorine. The bleaching powder solution may be prepared precisely as I have already described. This method of making up the solution entirely in a large mortar, is, I think, more easy of execution, and quite as satisfactory as that of transferring the solution and sediment with repeated rinsings to a measuring flask. One-tenth of the bleaching powder liquor is drawn by a pipette, and delivered into a small beaker. The arsenious solution is run into this from a burette graduated into cubic centimetres or grains to correspond with the other measures used. The operation is completed when a drop of the solution, lifted out upon a glass rod, no longer gives a blue or violet colouration when brought into contact with a slip of starch paper. The starch paper is prepared by soaking filter paper in a solution of iodide of potassium and starch. When dried it is cut into slips and preserved in stoppered bottles. No objection has been raised to this process, which, no doubt, gives accurate results, but it will be manifest that several of the precautions necessary to be observed in the execution of the iron process are quite as important in this. For paper-makers who have not the requisite laboratory appliances for delicate and accurate work, the arsenious solution could be prepared in the same way as recommended for the standard sulphuric acid.

The chemical agents which next claim our attention, are the various aluminous compounds used to precipitate the resin from the resin soap, and also for preserving animal size from putrefaction. The nature and effects of alum and the various alum substitutes form perhaps the most important chemical study connected with the paper trade. The only valuable constituent of all these substances is soluble alumina; this agent is chemically

companionised with sulphuric acid, forming sulphate of alumina, and it not unfrequently happens that there is more of the acid in the article than is required to form sulphates with the bases present; the excess is, consequently, a free and very active agent, asserting its presence injuriously in various ways, some of which have already been commented upon. Alum, which is the purest and best known of the agents referred to, is a crystalline substance, consisting of sulphate of alumina, sulphate of potash or ammonia, and water, forming what is known in chemistry as a double salt. The composition of the potash variety may be thus symbolised:—$Al_2\ K_2\ 4\ SO_4 + 24\ H_2\ O$; its crystalline form is that of the regular octahedron. The ammonia variety may now be regarded as little better than a chemical curiosity; the extensive development of the Strassfurt potash deposits having greatly cheapened this material, while, on the other hand, the largely increased agricultural demand for ammonia has raised its price enormously, thus placing it beyond the reach of the alum maker. There is no cause for regret in all this, as the potash variety is the more regular and serviceable article of the two.

"Sulphate of alumina" consists essentially of sulphate of alumina, but is always more or less contaminated with free acid. This article is not, like alum, a chemical compound of definite composition; the amount of the soluble alumina salt varies through one or two per cent., while the other and worthless constituents are mixed up in all proportions. There is but little insoluble matter in this agent, and in this is found its chief difference from alum cake, which usually contains about 20 per cent. The latter has generally a smaller proportion of free acid than the former.

Alumino-ferric cake, which is a comparatively new aluminous agent, is manufactured from the mineral bauxite by a process which renders the exclusion of free acid from the product easy.

Knowing something of the uncertain composition and the infinite trouble sometimes caused by the extreme acidity of alum substitutes, I, in view of these lectures, asked all the paper-makers in the kingdom to send me samples of the aluminous agents they were using, that I might be enabled the more fully to investigate this subject. In response to the request, I received a great number of samples, and also a number of letters stating that the writers used nothing but alum crystals, the composition of which did not require investigation. The various makers' samples were arranged, and two ounces of each sample ground up together, to form one average sample; the result of analysis showed the various agents to contain sulphate of alumina, free sulphuric acid, and iron (see Table).

Maker.	Substance.	Sulphate of alumina.		Alumina.	Free sulphuric acid ($H_2 SO_4$).	Iron calculated to $Fe_2 O_3$
H. D. Pochin and Co	Sulphate of alumina	40·34	=	12·10	4·72	·15
Mc Arthur and Link	Sulphate of alumina..........	41·68	=	12·50	3·70	·13
H. D. Pochin and Co.	Aluminous cake...	42 34	=	12·70	·30	·28
Cochrane and Co.	do. ..	38·34	=	11·50	2·06	.33
Winser and Co...	do. ...	40·68	=	12·20	1·24	.25
Peter Spence......	Alumino-ferric cake................	48·21	=	14·46	none	·77
Foreign............	Sulphate of alumina	48·54	=	14·56	none	none
Theoretical.......	Alum crystals.......	36·12	=	10·83	none	none

These results are instructive and require little comment on our part. All the British makes contain more or less iron, and all except Spence's alumino-ferric cake contain free sulphuric acid. The foreign make, of which I received three samples, is free both from iron and acid, and is certainly a very fine product, well suited to the wants of the paper-maker; I understand, however, that the price is such as to put it beyond the reach of the makers of all but the very highest classes of papers. It will be observed, that the cake made by Mr. Spence—who is so widely known for his scientific research, and his enterprise and success as a chemical manufacturer—contains a relatively large proportion of iron, which no doubt renders it less suitable for some of the finest white papers, but for news and most ordinary classes this will not interfere with its value, which, as a sizing agent, must rank very high, owing both to its high per-centage of alumina and the entire absence of free acid. Alum itself is singular in containing neither free acid nor insoluble matter, and in the uniformity of its composition, but it must not be forgotten that the sulphate of alumina in it, as well as in all the substitutes, is an acid salt liable to act upon strainer plates and machine wires if used in excess. The object in using sulphate of alumina in any of its forms in the sizing process is, as has been already indicated, to precipitate the resin of the resinate of soda. It must be borne in mind that that agent contains but a comparatively small proportion of soda, and that when more sulphate of alumina is used than is necessary to supply sulphuric acid to the soda, and thus precipitate the alumina, the excess retains its acid character. When the aluminous agent contains free acid, this will first act upon the resinate, forming a neutral soda salt, and precipitating free resin, which I have already stated to be undesirable in the pulp; using excess of such an agent both evils will accrue. By properly apportioning the precipitating agent to the resin to be precipitated, acid pulps may be entirely avoided. Of course this result can only be obtained in a satisfactory way when the precipitating agent contains no free acid; when it does, neutrality may still be secured, but always at the expense of so much resin being precipitated free. Both alum and alum cake contain a large per-centage of water which some consumers seem to regard as an important matter, and choose those which contain least. This is a very absurd procedure; the fact of one cake containing 10 or even 20 per cent. of water more than another is of no consequence whatever; the question of real importance being which contains most soluble alumina and least free acid, and, secondary to this, which contains the least iron and insoluble or gritty matters.

The estimation of alumina is a matter of some nicety, and not to be undertaken by any but experienced chemists. It cannot be done by any simple volumetric method, such as I have described as suitable for soda and chlorine, and

even when estimated by a trained chemist in a well-appointed laboratory, great care must be taken to secure strictly accurate results. Alumina is precipitated from the filtered solution by ammonia, but the precipitate is liable either to be too light or too heavy, just as certain precautions are observed or neglected. For details of the process I must refer to Fresenius, or any of the other leading analytical authors.

Of the minor chemicals we need only briefly notice hyposulphite of soda, or antichlor, used to neutralise the acidity of the bleached half-stuff. The action of this agent has already been described. The agent itself is composed of a sulphur acid containing a relatively large proportion of sulphur to the oxygen combined with it, and sodium oxide, with the constitution of which we are already familiar. Like most other crystalline bodies, its composition does not vary very much; if contaminated to any serious extent it will be by the admixture of foreign crystalline substances, deliberately added to reduce its value.

The strength of the oil of vitriol supplied to the mill will be ascertained by an ordinary hydrometer, while its freedom from colour will sufficiently indicate its purity for all paper-making purposes.

Before discussing the question of the disposal of the impure water discharged from various parts of the paper process, I may state that a laudable effort has been made by Mr. Wm. W. Ladelle to reburn the waste lime resulting from the causticising process and the preparation of bleaching liquor. I have seen the process in operation, and while it has not yet established its claim to be a complete success, it is an effort in the right direction, and will, I trust, ultimately accomplish all that can be desired. The disposal of these waste products is really a vexing question, and I am sure we must all wish Mr. Ladelle and his co-workers success in their efforts to convert what is at present a gigantic nuisance into a useful agent.

Many and varied have been the schemes proposed for the purification of waste engine and machine waters. Let the fact that the millowners of the North Esk—who have already adopted every "practicable and reasonably available means" of purification—are going forward in the present Session of Parliament with a Bill to empower them to take a pipe to the sea at a cost of over £100,000, testify to the insufficiency of them all. No doubt much has been accomplished on the stream referred to. I have, myself, devoted nearly four years to the problem, and considering the extent of the industry and the smallness of the flow of water, the result is not to be despised; still, however, as the law of Scotland stands, the riparian properties are entitled to demand absolute purity, even at the expense of stopping the industry altogether. So long as common law is allowed full sway in this direction, the Rivers Pollution Prevention Act of the year before last will be a dead letter. The old law is far more powerful and certain in its action than the new. The latter aims at the purification of streams from manufacturing refuse, having a care that the industries involved are not unduly harassed, whereas the former comes down unreservedly upon all polluters, demanding immediate and complete cessation of the pollution at any cost.

I am convinced that no process of filtration is applicable to the purification of the waste discharges referred to, until at least the grosser portion of the impurities are removed, either by simple subsidence or by precipitation with chemical agents, and I am further convinced that purification by precipitation with chemical agents is a delusion. No doubt the sedimentary matter may be very thoroughly separated, and an apparently pure discharge be the result; but I have yet to learn of a process that will reduce the grains of polluting matter, soluble and suspended, per gallon to a lower point than a good settling system without any chemicals will do, especially if the effluent water from the settling system is passed through a simple ash filter before being discharged. Chemicals are not to be had gratuitously, and their application on a large scale involves both plant, steam, and labour. It is better, therefore, to spend a little more money upon a well arranged system that will work itself, and require comparatively little attention, than a little less upon one that will involve a constant outlay.

Better than all the schemes of purification to which I have alluded, however, is that which begins in the mill itself. Let the boiling, cooling, and bathing liquids be so worked that the boiled materials may go into the engines so clean as to require little further washing; a better out-turn will be the result, and one half of the pollution obviated; and let almost the whole of the machine water be collected and rinsed, which will often be done at a profit, and will also conserve the purity of the streams. If precautions are taken under each of those heads, the volume and intensity of the polluted liquids to be purified will both be reduced, and the object aimed at made more easy of accomplishment. An efficient settling system should be capable of containing from 24 to 36 hours flow of the discharge; if the liquids are longer in the system they are apt to putrify, especially in hot weather, with a result which is certainly no improvement upon the original condition of things. Every settling system should be provided with the means of discharging and draining the sludge as it accumulates. If the drainers be well constructed, the sludge should lift in a caked form, easy of removal to the rubbish heap.

The system of purification which we have described in our report to the Rivers Pollution Commission, and which will be found, along with the accompanying plans, in their Fourth Report, Vol. I., pages 20 and 62, and Vol. II., pages 326 to to 334, has been but little improved upon, notwithstanding all the efforts that have been made to minimise still further the pollution of our rivers from paper manufactories.

SEVENTH ORDINARY MEETING.

Wednesday, January 23rd, 1878; Lieut.-Col. Sir E. F. Du Cane, K.C.B., R.E., Member of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Bailey, William, Horseley-fields Chemical Works, Wolverhampton.

Bethell, Charles, 38, Wood-lane, Uxbridge-road, W.

Byramjee, Rustomjee, M.D., F.C.S., 131, Inverness-terrace, W.
Faulkner, Robert, 20, Baker-street, W.
Ford, W., 5, Copthall-buildings, E.C.
Fynney, F. B., Pietermaritzberg, Natal.
King, Henry S., J.P., 65, Cornhill, E.C., and The Manor-house, Chigwell, Essex.
Newton, Harry Robert, 43, Seymour-street, Hyde-park, W.

The following candidates were balloted for and duly elected members of the Society:—

Ahrbecker, H. C., 117, Stamford-street, S.E.
Bennett, Dr. W. C., Hyde-cottage, Greenwich.
Bishop, Charles Kenwrick Kenelm, 18, Provost-road, Haverstock-hill, N.W.
Bray, Henry A., M.D., Queen-street, Market Rasen, Lincolnshire.
Cooke, Charles Wallwyn Radcliffe, 3, Essex-court, Temple, E.C., and 6, Cambridge-gardens, Notting-hill, W.
Goode, William, Thorn-lodge, Mulgrave-road, Sutton, Surrey.
Marshall, John, F.R.G.S., Auckland-lodge, Queen's-road, Richmond, Surrey.

The paper read was—

THE ART OF MARBLING.

By C. W. Woolnough.

The subject I am about to bring before your notice this evening, viz., the art of marbling, as applied to paper for bookbinding, and for the ornamentation of book edges, is one of which, in the general sense of the term, very little is known, and very little is recorded. Its origin and antecedents are involved in obscurity, and I have sought in vain for reliable information on this point.

Having seen some marbled paper on books bearing dates of a couple of centuries or more ago, I once thought it probable that might have been the time when it was first brought into use; but, as it is very possible that these books might have been either re-bound or repaired at a more recent date, when the marbled paper was applied, I gave up that idea as one on which no reliance could be placed. I was told many years ago, by an old man, that marbled paper of the old Dutch pattern used to be imported into this country from Holland; and, in order to evade payment of the duty, which was rather heavy, sheets of it were wrapped round small packages of toys, and thus passed free; these sheets being afterwards smoothed out, pressed, and sold at a highly remunerative price to the bookbinders; and I have occasionally met with some of these ancient specimens, which retained a marvellous softness and brilliancy of colour, and displayed a considerable amount of skill in their manipulation.

To any one seeing the process for the first time, it appears to be very easy, indeed I have heard many people observe, "Oh, any fool could do that, if they did but know how to mix up the colours." I am quite willing to admit this, but to mix the colours, and to keep them in good working order, is not quite so easy after all, as the chemical changes which are constantly taking place, and the influences of the atmosphere, will speedily prove.

I will now endeavour to tell you what the process is.

Marbling is the art of producing certain patterns or figures, by the means of colours so prepared as to float upon a surface of mucilage. Although several colours may be thrown, sprinkled, or laid on together, or one after another, yet they will still each retain a distinct position, and will not mix either with each other or with the vehicle on which they float; and thus, while floating, they may be formed into the desired pattern before being transferred to the paper, which is accomplished by gently and carefully laying the sheet of paper down gradually upon the floating colours, which will instantly adhere to the paper; and, when lifted out on a rod or lath, will leave the surface of the mucilage free for a repetition of the process.

Now we must observe that this is a very different thing to the manufacture of room or wall-papers, which is usually designated by the name of paper staining; this is all done with blocks of wood, cut and carved out by hand, and is, in fact, a kind of printing, so that an exact repetition of the same device can be produced *ad libitum*; whereas, in this process, the effects being natural, no two can be found exactly alike, though called by the same name, and passing for the same pattern; nor could any artist, with all his skill, produce a fac-simile of what may be accomplished by this method in a few minutes, were he to try for a whole month, or longer. Now, there are two questions which we will take into our consideration this evening, and the first is, "What is it that causes the colour to float and spread out upon the surface of the mucilage?" and, secondly, "What is it that prevents the colours from commingling or running into each other when they fall one upon another?" What is it that keeps each colour clear and distinct, though several may be thrown on at the same time, and though they may be even twisted round with a piece of wire, or pointed stick, as I shall show you presently. There are mysteries in all the operations of nature, some of which are very beautiful, and interesting to an inquiring mind. The great Michael Faraday himself, in one of his letters to me, observes, in reference to this art, "I feel much interest in the subject, not only on account of its associations with my early occupation of bookbinding, but also on account of the beautiful principles of natural philosophy which it involves;" so, however it may be despised, if it was not despised by, but was an object of interest to, that great and good man, surely it cannot be beneath our notice either. I will now endeavour, in a plain and simple way, to explain to you the so-called mysteries of this process, which some have so long and so jealously concealed from the vulgar gaze, and I verily believe that its extreme simplicity was the principal cause of the extreme watchfulness maintained by those who then practised it. Fifty years ago, it was almost as difficult to get a sight of the inside of a marbling establishment as it would be to get into the presence of Royalty; every crack and aperture, nay even the very keyholes, were stopped up or obscured, to prevent any glimpse being obtained as to the method by which it was accomplished; and, as comparatively few were in possession of its secrets, it was a very remunerative craft, and good profits were realised.

When I was about 13 years of age, I accompanied an individual who was going to fetch some books which had been sent out to be marbled; when we arrived they were not all finished, and your humble servant was admitted into the sanctum to wait for the remainder. I was so stricken with wonder and admiration at the sight, that I resolved in my own mind not to rest till I had found out how to do it. I will not now take up time by telling you of all the failures and the disappointments I met with; but at length, by unremitting toil and persevering efforts, I was in the end rewarded with success, and though for a long time the results were very imperfect, yet I could perceive that I had got hold of the root of the matter, and, after much practice, I, of course, approached nearer a perfect result; and as I was indebted to no one for the knowledge I had obtained, in the year 1853 I published a small work on the subject, which gave great offence to the fraternity, on account of its truthfulness, and the way in which the various kinds of marbling were set forth, and the manner of their accomplishment explained. You see here now before me a shallow vessel or trough, about 2½ or 3 inches in depth; it contains a thin mucilage. Now, there are several kinds of mucilage, viz., first, and most important, gum tragacanth, called by some gum dragon; secondly, linseed or flax seed; thirdly, Irish or Carrageen moss; fourthly, a seed, called among the initiated, flea seed, the name being given on account of its great resemblance to that well-known but troublesome insect, but really the seed of a kind of plantago, cultivated, I believe, in the south of France, and much superior to linseed, on the ground that it retains its properties a much longer time; besides one table-spoonful will produce as much mucilage as half-a-pint of the linseed. The mucilage used this evening is a solution of gum tragacanth. It requires two or three days to dissolve, and requires to be frequently stirred or beaten up during that time, in order to break the lumps, and to combine the gum with the water, after which it must be strained through a fine hair or muslin sieve before using. I shall now proceed to show you by what means the colour is made to float and expand upon the surface of this liquid, but first will prove that, without some other agency than water in the mixing of the colours they will neither float not spread, and there is but one thing at present known that will effect this. It is a very simple though subtle and powerful fluid—no expensive or elaborately prepared article; it is purely a production of nature, being nothing more or less than the gall of an animal. Ox-gall is the sort generally used; it is the easiest to be obtained, and is within the reach of all who may wish to try the experiment. I will not say that the gall of a horse may not be as effective as that of an ox, having never tried it; but I have tried the gall of sheep, and proved it much weaker, so that ox-galls diluted with water would be quite as good as that; but there is sometimes a great difference in the galls taken from different animals, some being far more powerful in their operation than others. The gall of one animal may be thick and ropy, which is objectionable, while that from another may be beautifully fluid, which is more pleasant to use. When fresh, it has no unpleasant odour, but when stale it is anything but agreeable, though none the worse for the required purpose; indeed, I consider it preferable.

I will now proceed to show you the action of the gall. I first draw this thin flat piece of wood, called a skimmer, over the surface of the solution trough. You ask me why I do this? I reply, because while I have been reading or speaking there has been forming on the top of the liquid a film or thin skin which, though imperceptible to the eye, is quite sufficient to frustrate the proper result. I now take a colour mixed only with water and allow a few drops to fall; it neither floats nor spreads, but falls to the bottom of the trough. I now pour a little gall into the same colour and again sprinkle some on the surface, this time, however, it floats and spreads all over the surface of the mucilage. I just lay on that a piece of white paper, and pouring into a glass a little water, I add a few drops of gall, and with a brush sprinkle it over the portion of the surface of colour not covered by the paper, and you will see that it has divided the colour into veins, thereby showing the effect produced by the gall when it is mixed with the colours; and in order to enable you to see the effect of this more vividly, I will lay on another piece of paper by the side of the first, and lifting the two out simultaneously, the operation or effect of the gall is clearly made manifest. This is the foundation of the whole process; this is the root from which all the branches spring, and although there may be other ingredients required to produce various effects, still these two simple productions of Nature—the gum and the gall—constitute the life and soul of this (as the late Dr. Normandy designated it) "pretty mysterious art."

In order to exemplify this more fully, permit me to give you another illustration, which I think will satisfy you as to the correctness of my statements. Take five different colours, viz., red, black, orange, blue, and buff. The first colour, red, is mixed with a small proportion of gall in it; the second with a little more; the third, orange, with more still; and so on, each succeeding colour requiring additional proportions of this fluid, in order to enable it to find a place for itself by displacing, or pushing aside, the previous colours, and driving them up into a smaller compass, thereby rendering them more intense and solid, and better adapted for their formation into such devices as the operator may desire.

First, I will apply the red; it spreads out over almost the whole surface of the solution, so that you can hardly perceive it, but I will, nevertheless, just lay down a small piece of paper after each colour, that you may see the effect more definitively when transferred to the paper than you can possibly do as it floats on the trough. Next comes the black. Thirdly, the orange; this is very plainly seen as it falls. Fourthly, the blue. And lastly, the buff, these comprise all the colours required for the production of some well-known kinds of papers, but still the pattern is not complete, and I shall have to repeat the process I have just gone through, and continue the manipulations from the point at which we left off, till something like a definite result is obtained. As I observed before, Dame Nature is a very fantastic creature to have to deal with, and the farther we go into

the subject, the stronger will be the proofs of this statement.

Now, after laying on all the colours, it rests entirely with the operator what shall be produced after all, for out of these few colours, as they now lie floating on the surface, a diversity of results can be obtained quite distinct the one from the other, and with a piece of pointed stick, a comb, or a piece of wire, you may indulge your fancy to almost any extent; and then, by diversifying the colours or the arrangement of the colours, an almost infinite variety of combinations and changes may be produced. Having disposed of the first question, viz., what is it that causes the colour to float and spread out upon the surface of the solution? we come to the second. What is it that keeps the colours from commingling, when they fall one upon the other? or in other words, what is it that keeps each colour clear and distinct, though several may even be thrown on at the same time, and though they may be even twisted round, nay, almost stirred with a pointed stick, every colour retaining its perfect individuality, though in so very minute a degree as to require a magnifying glass to reveal it. My humble opinion is this. The moment the colour touches the surface of the mucilage, it displaces a portion of mucilage itself, which forms a kind of bulwark or barrier around it, and thus prevents it meeting with the colours which had been previously put on, so that, were you to put on a yellow and immediately follow with a blue, there would be no signs of a green being produced, although if you were to mix the two colours together before you put them on to the mucilage you would have a decided green at once.

I have no intention of entering into a discussion upon acids and alkalies, chemical affinities, and combinations, as I do not profess to understand them, except in their action upon the materials connected with my present subject, and I think it better, therefore, to confess my ignorance at once on this point, than to occupy your time by pretending to explain anything beyond my power. This I know, that the more potent acids, such as sulphuric, nitric, muriatic, &c., would disarrange, nay, destroy, every attempt to produce the results I have just now exhibited, or may attempt to produce this evening. I believe acids are used in some of the cheap papers imported into this country from the Continent; but they find but little favour among competent judges of the art. A little alkali, however, is sometimes useful to correct the acidity in some of the colours, when they have not been sufficiently washed in the making, as also to soften the hardness of the water used in the preparation of the mucilage; but I will pass on to another peculiar feature in this process, and that is the very remarkable effect produced by a slight motion of the hand of the operator, while he is in the act of laying the paper down upon the colour as it floats, without the aid of any instrument whatever. This class of marbling has been discovered and introduced but little more than half a century, and was in reality quite a new feature in the art. It succeeded amazingly, obtained high prices, and an almost unprecedented demand, which continued for several years, until, as more people got into the way of doing it, and more expeditious movements were attained, it came into such general use that the public got tired of it, and it is now seldom used, except on work of a lower standard. The name given to it was Spanish; we are not to suppose by this that the name has any reference to its nationality, but simply to distinguish it from other kinds then in use, as French, Italian, Dutch, &c. Various stories are told concerning the way by which it was first discovered, some of them being ridiculous enough. I will just allude to two of them. The first is as follows:—One man was intently engaged on his work, and had all his colours laid on; just as he was on the point of laying down the sheet of paper, some other drove violently against him or the trough, by which the whole surface was agitated and set in motion like the waves of the sea, producing an effect which excited further inquiry and study, resulting in the production of this very pretty description of marbling. I have also been informed that the first that was made was produced in the following manner. When all was prepared for the laying on of the papers, one man got under the trough and shook it, so as to produce a wavy motion, when the paper was instantly applied by another, producing the wave-like appearance; these were, however, so broad and irregular, when compared with what is done by the present method, besides occupying two to do the work of one, that it fell into disuse as soon as the improved method was brought to light. Another story is this, and I am sorry to say that there is a considerable probability of there being some truth in it, as that bane of society, strong drink, is indulged to excess by many of those who are engaged in this calling. One of these unfortunates, with trembling hand and shattered nerves, went to his employment one morning, after a bout of drinking, driven, I suppose, by necessity; and when he came to lay the paper down, his palsied hand shook so much that he spoiled, as he admitted, every sheet of paper he attempted to make. Some of these attracted the attention of the principal, to whom the cause was explained, and the light thrown on the subject gave rise to further investigation, till at last the perfect development was obtained. I do not vouch for the truth of these narratives. I give them to you just as I received them, and hold myself in no way responsible for their veracity, but leave you to form your own opinion, and judge for yourselves. But I must pass over some very interesting varieties, as I would not trespass beyond the usual bounds. I should like, however, to show you the way in which this Spanish is varied, which I think will interest you when you see how trifling a thing makes a great difference. In this experiment I will produce on one piece of paper the lights and shadows in diagonal lines, while on the other they will be shaded something like watered silk.

There is one more variety to illustrate, of quite a different character to any of the former; in this several colours are put on at once without the aid of brushes, and by this method a considerable degree of uniformity can be obtained. It is one of the oldest styles of work revived and modernised, and is in great demand at the present time for antique and the better class of binding. It is called old Dutch, and consists of several varieties, some large, some small, some curled, some not, but all, so far as the laying on of the colours is concerned, conducted on the same principle, the

varieties being produced by the manipulations after the colours have been laid on.

Now, if you will attentively observe a whole sheet of this class, you will perceive that the colours are not scattered promiscuously over the whole, but follow each other in a kind of regular succession, in a diagonal direction across the sheet, red being the preponderating colour. In order to accomplish this, a number of little pots, or tins, are required, about $1\frac{1}{2}$ in. or 2 in. inches wide, and 2 in. or 3 in. deep. Small jam pots will do very well. You will also require two frames, fitted with wooden pegs, and placed at regular distances apart—about four or more inches—having the appearance of a farmer's harrow in miniature. The frames of pegs must correspond with each other in every respect, so that, if you made an impression with one frame on a sheet of paper, the other ought to fit exactly upon the impressions produced by the first; because the colours you will have to apply with the second frame will be placed exactly in the centre of the colour put on with the first.

The pots must now be arranged in two divisions, an equal number in each, and adjusted so as the teeth or pegs of the frames will drop in the centre of each pot, as you will have to give a motion to the frame to stir the colours, as they soon settle; one of these divisions of pots must be half filled with white or ground pipeclay, the other with three different colours, arranged in the following order, the number varying according to the size of your paper. Y stands for yellow, B blue, G green:—

G	Y	G	Y	G	Y
Y	B	Y	B	Y	B
G	Y	G	Y	G	Y
Y	B	Y	B	Y	B
G	Y	G	Y	G	Y

Instead, however, of having pots for the white, you may have a trough or vessel the size of your frame, about three inches deep, for the reception of that colour, which will answer the purpose equally well and with less trouble.

The red, which is the first colour to be applied, must be sprinkled on with a brush, and the surface well covered, then lift carefully the first frame, consisting of the white, giving it a rotary motion so as to stir up the mixture, and let the extremities of the pegs with the colour on them just touch the surface of the mucilage in every part; put it back in the colour, and quickly take the other charged with the three colours, and in like manner let that touch just in the middle of the spots of white, then with a tapering piece of wood—the handle of a brush for example—draw the colours in a parallel direction up and down, from front to back, after which draw the comb through the colour, from left to right, and the pattern is complete, unless you think fit to add curls or any other device, which, of course, must be left to your own discretion.

Thus far we have gone without the aid of any other agent in the colours than gall, and there are many more varieties to be produced by the same material. There are also some very pleasing results to be obtained by the use of other agencies, but it is impossible to compress them into the compass of one single paper. I could have enlarged on this part of the subject to-night, and have mentioned many strange and interesting facts regarding this art. What I have so imperfectly revealed to-night has, I hope, proved that there are many things in everyday life which escape our notice, simply because they are common, but from which we might draw much that both interest and enlighten us, if we would but exercise the powers with which God has invested us, and placed us so far above the inferior creation. With one more experiment I will now close this paper, and that will simply be to show that whenever the paper is wetted with the solution, no colour will adhere to it while the moisture remains on its surface. I will now wet some part of the paper, and after preparing a surface of colour on the trough, will lay on this sheet of paper, and, on lifting it out, you will see that the part wetted will be bare of colour, while the part that remained dry is perfectly marbled.

The various methods of producing the different descriptions of marble paper were illustrated by Mr. Woolnough, who made a number of specimens in the room. Examples of the printed paper were also exhibited, as well as specimens of the materials employed.

DISCUSSION.

A Member asked if the marbling of book edges was done by the same process as had been shown for the manufacture of marbled paper?

Mr. Woolnough said the operation was exactly the same, except that the book edge being stiff, it had to be put a little lower into the trough, in order to insure the whole surface being covered, otherwise there would be the probability of a bubble of air being included, which would spoil the effect. The book was therefore put down into the solution until the operator saw what he called the "fore-edge" touch the surface, when it was taken out. There was no difference in the preparation of the surface or in the manipulation. There was plenty of room for a second paper in which other materials used might be described, and if he ever he had the honour of illustrating the subject again, he would go into the matter of book edges, which he had simply omitted for want of time.

The Chairman said he was sure all present would concur in the vote of thanks which he would beg leave to propose to Mr. Woolnough for his interesting paper. It had shown him that a subject which at first sight seemed to be one of very limited interest, might, by a person well acquainted with it, and who could speak lucidly upon it, be made one of considerable interest to those who heard it. It had been illustrated in a very skilful manner, and they had heard incidentally, also, that drunken men might sometimes have their uses. He hoped that anecdote would not be misapplied; but it might be a comfort to those who were in the habit of indulging to find that they were of some use occasionally. The effects produced by this process were, more or less, dependent upon chance; but it had occurred to him that if it were taken up by artistic people, they might make something more of it than had hitherto been done.

The vote of thanks having been passed unanimously,

Mr. Woolnough thanked the audience for their attention and appreciation, and the proceedings terminated.

Arrangements have been completed for opening a class for instruction in house carpentry and pattern making at the Manchester Mechanics' Institution. The instruction given is intended to convey a thorough knowledge of the use of the tools employed in this branch of industry.

MISCELLANEOUS.

THE LATE MAJOR-GENERAL F. M. EARDLEY-WILMOT, R.A., F.R.S.

The following circular has been issued by a committee formed for the purpose. Although this appeal has been addressed specially to brother officers of the late General Wilmot, it is hoped that others who knew him will also contribute. Any subscriptions will be gladly received by the Secretary of this Society, or may be paid to Messrs. Cox and Co., Craig's-court:—

Some of the personal friends of this lamented officer desire to make an appeal to their own and his brother officers to unite in preserving his memory by some fitting memorial.

The form to be given to it must depend upon the amount raised, and it is only necessary to remark that it does not fall within the scope of their intentions to add to the memorials already erected in the garrison church at Woolwich. Something of the nature of a scholarship or endowment in connection with the Royal Military Academy is contemplated, if the fund shall permit; a bust, or picture, if it should fall short of the sum necessary for that purpose.

Major-General Eardley-Wilmot had not the good fortune to participate in any active service of importance. It was one of the fixed principles of his life to give himself up to the will of that higher power which he believed to be his guide, and not by acts of his own to seek for opportunities of distinction. The only opportunity which presented itself he seized with eagerness; and, deeming his duty as a soldier paramount over his duty to science, he left the Magnetical Observatory at the Cape of Good Hope to serve upon the general staff in the Kafir war of 1842. Before the Crimean war had assumed the proportions it ultimately did, his energy and talent had been directed into another channel, and as superintendent of the Royal Gun Factories he was mainly instrumental in giving effect to that enlightened policy of Mr. Monsell (now Lord Emly), by which the Royal Arsenal was rapidly raised from a condition unworthy of the mechanical advance of the day, into the splendid group of establishments now known to the world.

His profoundly religious mind was sustained by a manliness and chivalry of character which made him a noble type of the British officer, and qualified him in every position of life to be a leader of men. This was especially evinced during the period in which, as Captain of the Cadet Company (1847 to 1854), it was brought to bear directly on the impressionable and generous minds of young men. Few officers who passed through the Academy under him can have forgotten the influence he exercised, the manner in which he was looked up to, or his unwearied efforts for their good.

This is not intended as a biographical sketch, and therefore it is sufficient to allude to his command of the artillery in Canada (1860 to 1862), and his command of the School of Gunnery at Shoeburyness (1864 to 1868), as occasions which enabled him to hold up the high standard of duty ever before his own mind to the imitation of others, and to set an example of loyalty to the regiment of artillery, of soldier-like bearing, of high-minded independence within the bounds of discipline, and of ever-earnest activity in schemes of benevolence.

After his removal from the regiment by promotion, he continued to sustain its reputation and his own by an active share in the work and management of the Society of Arts, of the Council of which he was Chairman, till the year before his decease.

He was born in May, 1812, and died (after a long and very painful illness, borne with manly courage, Christian submission, and unselfish cheerfulness) 30th September, 1877—by one day too soon to receive promotion to the rank of Lieut.-General, to which he was actually gazetted on the 1st October.

The following officers have signified their approval of the purport of this notice, and their desire to contribute:—

General Sir John Bloomfield, G.C.B.
Lieut.-Gen. Sir J. Fitzmayer, K.C.B.
„ W. J. Smythe, F.R.S.
„ Sir J. H. Lefroy, C.B., K.C.M.G., F.R.S.
„ H. H. Maxwell, C.B.
Major-Gen. Sir J. M. Adye, K.C.B.
„ R. P. Radcliffe.
„ Samuel E. Gordon, C.B.
„ E. Wray, C.B.

A small committee will be formed, of which Lieut.-Gen. Sir J. H. Lefroy will be Chairman, and Major-Gen. S. E. Gordon, Hon. Secretary.

CLASSES FOR COOKERY.

The *Workmen's Club Journal* states that an effort is now being made to induce the Science and Art Department to add food and cookery to their list of science subjects, and suggests that clubs and institutes might render essential service by adopting the following memorial and forwarding it, when signed by the chairman and secretary on behalf of the club, to the office at South Kensington for presentation. There is no reason why some of the institutes should not have classes for cookery during the winter. The want of this knowledge must be felt in many homes, and the food cooked might often be sold to the club members.

To the Right Honourable the Lords of the Committee of Privy Council on Education.

The Memorial of the undermentioned Working Men's Clubs respectfully sheweth,—

1. That the attention of your memorialists has recently been directed to the importance of a knowledge of food and cookery as part of the education of girls in public day and evening schools.

2. That your memorialists are of opinion that much waste and ill-health would be avoided in the homes of the people, if girls were instructed in the theory and practice of cookery.

3. That your memorialists regard with satisfaction the introduction of "Domestic Economy" in the Education ode of 1876 as a compulsory specific subject for girls; but that it appears to your memorialists that theoretical instruction in the branch of domestic economy connected with the subject of "Food and its Preparation" will prove comparatively worthless if unaccompanied with practical instruction in cookery, with such utensils as are usually found in the homes of the working classes.

4. That your memorialists would respectfully remind your Lordships that under the regulations of the Science and Art Department of the Committee of Privy Council the teaching of "chemistry" is aided by payments both on theoretical and practical knowledge, which leads your memorialists to think that some analogous arrangement might be made for encouraging a theoretical acquaintance with the chemistry and physiology of food, and practical knowledge of the most economic methods of its preparation.

5. That while your memorialists have noted with satisfaction the recent addition of the "Principles of Agriculture" to the list of subjects aided by your Lordships through the Science and Art Department, they cannot help thinking that an acquaintance with the

principles and practice of cookery is quite as necessary in the education of girls as an acquaintance with the former subject is in the education of boys.

Your memorialists would therefore humbly pray—

(1) That besides enacting the introduction of domestic economy as a specific subject for girls in day schools, your Lordships would be pleased to provide that direct payments may be made to classes in day and evening schools on the results of instruction in practical cookery to girls on the same principle as payments are now made through the Science and Art Department for instruction in various branches of elementary science.

(2) That aid be given to the proper fitting up and furnishing of places for practical instruction in cookery; and,

(3) That female teachers be encouraged to pass special examinations with a view to the teaching of cookery.

And your memorialists will ever pray.

ENGLISH TAPESTRY AT WINDSOR.

Upon the confines of the Royal demesne at Old Windsor there has arisen, says the *Times*, an industry which, with a little careful nursing on the part of the projectors, may prove a valuable acquisition to the manufactures of the country. The Windsor Tapestry Works, just established at the Manor-lodge, under the immediate patronage of her Majesty, bids fair to re-introduce an art which for several centuries has been lost to us, but which still flourishes among our neighbours in the South of France. It was about the time of King Charles the First that tapestry weaving was introduced into England, when a factory was opened at Mortlake, in Surrey. Charles II. sent for Verrio to paint the cartoons; but, unfortunately for the success of his new art, his Majesty found plenty of other occupation for him, and for the greater part of his time he was employed in decorating the interior of Windsor Castle, where he painted the ceilings of the State ante-room and Audience and Presence Chambers. After this tapestry weaving at Mortlake languished, and ultimately ceased entirely, and since then, till the present time, the art has never been cultivated here to any extent. Prince Leopold is the president of the undertaking, the vice-presidents being Princesses Christian and Louise, Lord Ronald Gower acting as honorary secretary, with Mr. H. Henry as director. A number of looms are at work at Manor-lodge, the weavers, male and female, having been brought from Aubusson for the purpose of instructing English learners, under the superintendence of M. Brignolas, the manager. Several weavers sit at each loom, the cartoon pattern lying beneath the white horizontal threads stretched out before them, and through which it can be easily seen when required. Near each worker lies a heap of long, thin wooden reels, crewels of some thousand shades being used in the tapestry. With the left hand the horizontal threads are lifted, while the worker passes the reels of crewels between them, fastening off each tint and pattern as he completes it. Tapestry weaving by the most skilful is a very slow progress, and, let the artisan use his fingers ever so deftly, he will not complete more than a square foot within four days, while ten days would be required when the cartoon is very elaborate or great skill necessary. The French *employés* at the Royal Tapestry Manufactory begin work at eight, and weave till half-past six, earning at the rate of 10d. an hour, most of them living in the village and providing for themselves. At present some important specimens of tapestry are on hand, while one, a bust size portrait of her Majesty, a *fac-simile* of the picture by Angeli, in the ball-room of Windsor Castle, has been completed. There is also a series of eight cartoons, 10 ft. in length and 7 ft. wide, depicting various scenes from Shakespeare's "Merry Wives of Windsor," some of which have been finished. These, with the portrait of the Queen, are destined to adorn the *salon* at the Paris Exhibition which will be used by the Prince of Wales as president of the British Commission. The whole were designed by Mr. T. W. Hay, the subjects including "Anne Page and Slender," "Ye Merrie Wives," "Sir John Falstaffe," "Dr. Caius," "Sir H. Evans," "Ye Witch of Brentford," "Herne's Oak in Windsor Park," and "Anne Page and Fenton." Other rooms are occupied with the production of a series of hunting tableaux, the cartoons for which are from the brush of Mr. E. M. Ward, R.A., of Windsor, the tapestry being intended for the decoration of the town mansion of Mr. Christopher Sykes, M.P. The subjects are "The Start," and "Taking of the Stag" and "The Boar Hunt," the costumes being those of Henry VIII.'s time. In addition a beautiful sofa cover, in the Louis XVI. style, is being manufactured for the Queen, the ground tints being cream colour, silver gray, and light green, the centre of the back being ornamented with a medallion containing the monogram "V.R." and crown, and surrounded with wreaths of wild roses. Attached to the works is a stained-glass studio where several artists are employed on mediæval work. Her Majesty, who with other members of the Royal Family takes great interest in the tapestry works, has given some Crown land near the Manor-Lodge for the erection of a more commodious factory. This will be a very handsome Gothic building constructed of red brick and white stone.

MINERAL RESOURCES OF BRITISH BURMAH.

In British Burmah, the metalliferous minerals are chiefly found in the Tenasserim division: tin in Mergui and Tavoy; lead in Maingay Island, Amherst, and Toungoo; iron in Amherst and Shive-gycen; copper and antimony in the hill confines of Toungoo. Gold exists in the Shive-gycen river, a stream which flows from the western hills. A special report on the minerals of this division was submitted by the late Mining Geologist in May, 1875. After prolonged local inquiries he came to the conclusion that the minute quantities of gold which appear to be found do not come from quartz reefs, nor are they brought down the rivers from their sources, but are sparsely disseminated throughout the granite of the country, where they are found in the disintegrated *débris*. Tin is the only metal which is worked scientifically and well. The mines to the south of the Mergin district, in the townships of Lenyah and Malewoon, have always attracted considerable attention; and the ore is said to become more plentiful the further south it is followed. A European firm, three years ago, took a lease of the Malewoon mines, and have opened out roads and imported machinery, with a view to their thorough exploitation.. Several large and valuable lodes have been struck, pronounced to be equal in yield to some of the best Cornish mines; but the out-turn of metal has hitherto been inconsiderable, owing to the time which has intervened in obtaining machinery and the milling furnaces. Large quantities of the crushed ore have, however, been collected, and are available for smelting. Elsewhere, the mines are worked by Chinamen, who use no machinery, but excavate cuttings from 15 to 20 feet below the surface. The metalliferous deposit is smelted in a rude kind of furnace.

Arrangements are being made for the holding of an International Exhibition at Sydney in 1879, under the auspices of the Agricultural Society of New South Wales. It is anticipated that many of the articles shown at the coming Paris Exhibition will be trans-shipped to Sydney.

THE COMMERCE AND INDUSTRIES OF JEDDAH.

The report by Consul Beyts states that Jeddah presents a sandy and barren appearance, in character with the whole seaboard of the Hedjaz. In the interior, where the soil is said to be capable of cultivation, owing to great scarcity of water rural pursuits and agricultural operations are entirely neglected; and with the exception of small quantities of senna, grown in the direction of Mecca, this portion of the Hedjaz country establishes no claim to either agricultural or mineral products. At the southern limits, a small quantity of coffee is grown, but the bulk of this staple is the native produce of the Yemen.

The imports consist chiefly of wheat, barley, and dates from Busreh; tobacco, carpets, ghee, &c., from the Persian Gulf; rice and sugar from Calcutta; pepper, spices, dyes, cocoa-nut, and essential oils, canoes from the Malabar coast, *viâ* Bombay; sugar, rice and teak wood from the Straits Settlements; occasionally a cargo of rice from Rangoon; grains, beans, soap, &c., from Constantinople; flour, petroleum, and sundries, from Trieste; cereals from Yemen and the Red Sea littoral; cloves and cocoa-nuts from Zanzibar; tin, iron, loaf sugar, piece goods, and manufactures from the United Kingdom. An endless variety of piece goods is to be seen in the bazaars, high-class goods of standard makers are not sought for, and in many instances the trade mark is sufficient guarantee. A direct trade with Manchester is being steadily developed, which has hitherto been exclusively in the hands of Greek and Egyptian merchants resident in Cairo and Alexandria. The products of Jeddah itself are literally nothing; but, from its position and wealth, much of the produce of the African and Red Sea littoral there finds an emporium. Coffee is brought in by steamers and native craft from the ports of Yemen, and re-exported to Syria, Egypt, the Mediterranean, Continental ports, and London. Mocha coffee is everywhere famed, but the cultivation is still rude, and no endeavours are made to improve the berry, which is shipped dirty, and frequently unripe. The different Arabic gums are largely brought over from the Suakim and the Nubian coast, and re-exported to India, Trieste, and London. During the summer months many tons weight of valuable mother-of-pearl shells are brought in from the adjacent fisheries. Many of the boats employed are owned in Jeddah; the shells are stacked and assorted, and sold by auction, purchasers paying duties, &c. The trade has fallen off considerably of late, but is still very important. Hides and skins are exported largely to India and Europe, but the value is lowered by the crude and careless method of flaying. Many thousand skins are annually converted into buckets for holding water. The nominal currency is piastres, but all mercantile transactions are in dollars. English gold is scarce, French and Turkish abundant. The standard coin, however, is the Maria Theresa dollar. The weight and measures are very intricate, and require especial study; the Government scale is similar to that used at Constantinople.

The industries consist in the weaving of a coarse cotton fabric, embroidering with gold and silver threads on silk vestures, band and neckerchiefs, puggeries, ornaments, &c., dyeing of cloths, leather, &c., lacquering on wood, furniture, toys. Turning, chiefly of a substance said to be black coral, into beads, cigarette holders, crucifixes, and other ornaments, wood-carving of doors, windows, balconies for houses, house and boat building; the latter forms an extensive branch of the industry of Jeddah. The merchants as a class are wealthy and enterprising; as bankers they advance on mortgages of houses and ships, and otherwise carry on an extensive discounting business; they are proprietors of houses, sailing ships, and bungalows; their commercial transactions extend to India, Singapore, the Persian Gulf, Egypt, Constantinople, and Europe; the Moslem religion forbids the insurance of ships and merchandise, consequently heavy losses have occasionally to be borne. The middle class consist of brokers, retail shopkeepers, artisans, coffee and smoking shop proprietors. The Greeks and Maltese own several of the latter establishments, in which they make large gains by clandestinely vending a drugged liquor called mastic to the Arabs. The larger portion of the labouring class are boatmen; they are unscrupulous, and as exacting as can be; there is no Government tariff which regulates boat hire, consequently the profession is made lucrative. The Arabs are orthodox, bigoted, fanatical Moslems; and nowhere is the law which the Koran inculcates for the seclusion of women more rigidly observed than at Jeddah. Hence the impossibility of arriving at anything more than an approximate estimate of the number of the population; but on the best available information, it may be fixed at 30,000 persons.

CINCHONA CULTIVATION IN INDIA.

The report upon Indian progress during the year 1875-76 states that in British Sikkim, after 13 years of expenditure on the chinchona plantations, at first in experiments, the scale began to turn in 1875-79. In that year no addition was made to the permanent plantations, but the main work consisted in gathering a crop of 211,931 lbs. of red bark. This yield was more than five times as great as that of the preceding year. The cinchona plantations in the Darjeeling district covered 1,800 acres, and were stocked with about 3,000,000 trees, of which 2,600,000 are of the *Succirubra* and 350,000 of the *Calisaya* species. The bark of the latter yields chiefly one alkaloid, quinine, the isolation of which can be cheaply accomplished in India; while, in the case of the *Succirubra* variety, the separation of the quinine from the other alkaloids would cost too much to be profitable. The *Succirubra*, however, contains mixed alkaloids, which, if they could be produced in sufficiently large quantities, would afford a cheap febrifuge for the mass of the people. The present plantations, it is estimated, can in future supply annually about 400 lbs. of *Calisaya*, and 10,000 lbs. of *Succirubra* alkaloids. This quantity, large as it is, would be quite inadequate for general distribution, and the expediency was therefore under consideration of extending the plantations towards the south-east, where the ground presents remarkable advantage as to soil, elevation, and temperature. The quantity of dry bark used by the quinologist in manufacture during the year, was 107,310 lbs. This yielded only 1,982 lbs. of cinchona febrifuge, but more than one half of the bark was branch bark, which is always poor in alkaloids. It is estimated that 366,000 lbs. of dry bark would be collected in 1876-77; and it is hoped that the febrifuge may be supplied to the public at a cost of less than one rupee per ounce. The alkaloid factory was to be transferred to Calcutta, and worked upon a larger scale in either the Presidency or the Alipore jail. It will there be more under professional supervision, and have greater advantages in respect of mechanical appliances.

In gathering the bark, attention was paid to the important objects of assuring future cultivation, and of adding to the practical knowledge of the best methods of harvesting. The practice of uprooting the entire tree was adopted, in order to save the loss of bark which arises from the fact that, after coppicing, a certain proportion of the stools fail to shoot.* The root bark thus made available for manufacture was found to contain about 8 per cent. of alkaloids, or 1 per cent. more than the finest stem bark. The practice of stripping bark from living trees was not resorted to during the year, as it was found that the removal of bark under moss was

* See *Journal* for February 9, 1877, pp. 226, *et seq.* vol. xxv.

rendered impossible in Sikkim by the attacks of ants. It is thought probable that this method of harvesting bark, which is so successful in the Nilgherry plantations, will be entirely abandoned in Sikkim.

In Madras, in the Nilgherry plantations, at the close of 1875-76, the total number of chinchona plants was 1,190,458, about equally divided between the *succiruba* and *officinalis* species. The harvest of the year amounted to 65,170 lbs. The season was a favourable one for the plantations, though owing, it is believed, to the deficient rainfall, some slight damage was caused by unusually severe frost. The importance of careful weeding and watering was demonstrated by the more vigorous growth of the plants and increased yield of bark. On the other hand, special manuring was not followed by any appreciable effect. The advantage of the mossing over the coppicing process was also established by the experience of this season, as regards both more speedy production and superior quality. The objection existing to this process in Sikkim and Ceylon, owing to the attacks of white ants and other insects, does not apply to the Nilgherry plantations.

A NEW METHOD OF RENDERING GLASS OPAQUE.

The various methods now in use for rendering glass opaque, are, first, painting or covering one of the faces with any opaque white substance, such as alabaster, barytes, &c., mixed with oil. Second, causing the surface to be attacked by hydrofluoric acid. Third, covering the surface with ground glass in powder, and submitting the whole to vitrification at temperatures low enough to cause adherence of the powder without producing deformation of the sheet. Fourth, grinding the surface with emery. Fifth, abrading it by the sand blast; and sixth, depositing thereon a salt in crystalline form.

A new process has recently been devised by M. Aubriot, by means of which he produces so-called muslin glass, of a great variety of colours. He proceeds as follows:—After carefully cleaning the surface a layer of vitrifiable colour is laid over it. The vehicle is simply gum water, and care is exercised that the pigment is evenly applied. The glass is then submitted to a mild heat until the water has evaporated, when a stencil of the desired pattern is laid over the surface, and a stiff brush is used to remove the loose pigment from the parts which are to be transparent. The glass is next inclosed in a frame, and above it is extended a piece of tulle, or, if desired, embroidered lace, the embroidery in the latter case being so disposed as to harmonise with the ground pattern previously made. The whole is then hermetically closed in a box, which contains in its lower portion a reservoir in which is a certain quantity of dry colour in the form of impalpable powder. This, by an air blast, is blown evenly upon the glass, and adheres to the latter wherever the surface is not protected by the threads of the lace. In this way the pattern of the latter is defined. In order to fix the powder, the sheets of glass are placed in a steam chamber, where the steam moistens the gum and causes the powder to adhere. The colour is then burned in a special furnace. By using different colours, it is said that very beautiful designs can be produced in this way, opaque or transparent, according as the pigments themselves are the one or the other. Remarkable effects also are obtained by the superposition of the tints.—*Furniture Gazette.*

There was a decrease last year in the importation of guano. In 1876 the value was £2,461,885, and last year £1,166,664.

The declared value of beef imported last year "fresh or slightly salted" increased from £462,947 to 1,266,280.

GENERAL NOTES.

Musical Education in Lancashire.—A meeting is announced to be held in Manchester on Wednesday next, the Bishop of Manchester in the chair, to consider the best means of promoting musical education in Lancashire. Mr. Edward Hecht, the Professor of Music at the Owens College, has consented to act as hon. secretary for the county of Lancashire, and will be happy to receive the names of well-wishers to the national cultivation of music.

The Telephone.—The *Daily News* has been the first journal to make a practical application of the telephone to newspaper purposes. On the evening of the 22nd inst., communication was established between the House of Commons and the office of the *Daily News*, in Bouverie-street, by means of the telephone, which is specially attached to the ordinary telegraphic wire running between the Houses of Parliament and the *Daily News* office. Conversation was distinctly audible, despite the noise from the other wires, and part of the Parliamentary debate and summary in the next morning's paper was received by this novel and interesting agency.

Scales for Drawings.—Mr. Edwin Lawrence recently wrote to the *Times*:—"It may be valuable to those of your readers who intend to exhibit plans or models at the Paris Exhibition to know that these can be made to a scale capable of being expressed in any language. The only common measures between English feet and inches and foreign decimal scales are the numbers 2 and 10, so the only possible international scales are the following:—Full size=grandeur naturelle; half full size, or 6 in.=1 ft.=la moitié ou ·5; quarter full size, or 3in.=1 ft.=le quart ou ·25; 1½ in.=1ft.=·125; ¾ in.=1 ft.=·0625. Or 1-10th of any of the above—viz.:—12-10 in.=1 ft.=·1; 6-10 in.=1 ft.=·05; 3-10 in.=1 ft.=·025; 3-20 in.=1 ft.=·0125; 3-40 in.=1 ft.=·00625. A drawing has only to be made of any of these scales, and marked with the English words, and the corresponding decimal will be understood all over the world."

NOTICES.

PROCEEDINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at eight o'clock. The following arrangements have been made:—

JANUARY 30.—"The Art Manufactures of Japan." By CHRISTOPHER DRESSER, Esq., Ph.D. Sir RUTHERFORD ALCOCK, K.C.B., F.R.G.S., will preside.

FEBRUARY 6.—"Higher Commercial Education." By JOHN YEATS, Esq., LL.D.

FEBRUARY 13.—"The Systems of Cremation in Use upon the Continent." By W. EASSIE, Esq. HIGFORD BURR, Esq., will preside.

FEBRUARY 20.—"The Steam Tramways of Paris," by J. L. HADDAN, Esq., M.I.C.E.

FEBRUARY 27.—"The Past, the Present, and the Future of the River Thames." By J. B. REDMAN, Esq.

MARCH 6.—"On an Electric Lamp-lighting System." By ST. GEORGE LANE FOX, Esq.

MARCH 13.—"The Type-writer." By R. BRUDENELL CARTER, Esq., Member of the Council of the Society.

MARCH 20.—"Emery and Corundum Wheels for Grinding and Surfacing Metals and other Materials." By A. H. BATEMAN, Esq., F.C.S.

MARCH 27.—"Musical Education at Home and Abroad." By ALAN S. COLE, Esq.

African Section.

Tuesday evenings, at eight o'clock. The following arrangements have been made :—

February 19.—"Egyptian Obelisks and their Relation to Chronology and Art." By Basil H. Cooper, Esq., B.A. Admiral Sir Erasmus Ommanney, C.B., F.R.S., will preside.

Indian Section.

Friday evenings at eight o'clock. The following arrangements have been made :—

February 1.—"The Destruction of Life in India by Wild Animals." By Sir Joseph Fayrer, M.D., K.C.S.I. Sir George Campbell, M.P., K.C.S.I., D.C.L., will preside.

February 22.—"Irrigation Regarded as a Preventive of Indian Famine." By W. T. Thornton, Esq., C.B.

March 15.—"The Colonisation of Hill Districts in India." By Lieut.-General McMurdo, C.B. Edwin Chadwick, Esq., C.B., will preside.

March 29.—"The Depreciation of the Value of Silver, with Especial Reference to the Exchange between India and England. and Suggestions for a Remedy." By Col. J. Smith, R.E., late Superintendent of Madras Mint.

Chemical Section.

Thursday evening at eight o'clock, The following arrangements have been made :—

February 14.—"Recent Improvements in the Metallurgy of Nickel." By A. H. Allen, Esq., F.C.S.

February 28.—"The Chemistry of Infection, or the Germ Theory of Disease from a Chemical point of View." By C. T. Kingzett, Esq., F.C.S.

Additional Lectures.

A Course of Three Lectures, on "Explosions in Coal Mines," will be delivered by T. Wills, Esq., F.C.S., on the three following Monday evenings, at Eight o'clock, January 28th, February 4th, and February 11th.

Lecture I.—January 28th.

The nature of the Coal Measures. Mining for coal. Ventilation of mines. Composition of coal. Occurrence of fire-damp or marsh gas in mines. Nature and properties of fire-damp. Dangers connected with its presence.

Lecture II.—February 4th.

After-damp or choke-damp. Methods adopted to allow of safe working in fiery mines. Various appliances for lighting mines. The nature of the safety lamp. Different forms of this lamp.

Lecture III.—February 11th.

Connection of the variations of atmospheric pressure with explosions in coal mines. Dangers attending blasting operations in coal mines. Action of coal-dust in certain classes of explosions. The use of the safety lamp as an indicator of the presence of fire-damp, also as a means for its quantitative estimation.

Cantor Lectures.

Monday Evenings, at Eight o'clock. Second Course, on "The Application of Photography to the Production of Printing Surfaces and Pictures in Pigment." By Thomas Bolas, Esq., F.C.S.

Lecture I.—February 18th.

Photo-lithography and photo-zincography.

Lecture II.—February 25th.

Phototypic, or raised printing blocks, by swelled gelatine process, zinc etching, and other methods.

Lecture III.—March 4th.

Line engraving on metal plates.

Lecture IV.—March 11th.

Printing of half-tone subjects from metal. Application of Asser's process. Talbot's Photo-engraving. Woodbury's methods for engraving and printing.

Lecture V.—March 18th.

Collotypic printing.

Lecture VI.—March 25th.

Other methods of producing photographs in pigment. Dusting-on method. Autotype printing.

Third Course, on "Some Researches on Putrefactive Changes, and their Results in relation to the Preservation of Animal Substances." By B.W. Richardson, Esq., M.D., F.R.S. April 8, 15; May 6, 13, 20, 27.

MEETINGS FOR THE ENSUING WEEK.

Mon.....**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Additional Lectures.) Mr. Thomas Wills, "Explosions in Coal Mines." (Lecture I.)
Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. J. Smalman Smith, "The Law of Support in its relation to Land, Mines, and Buildings."
Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m.
Institute of Actuaries, The Quadrangle, King's College, W.C., 7 p.m. Mr W S. B. Woolhouse, "The Adjustment of Mortality Tables."
Medical, 11, Chandos-street, W., 8 30 p m.
London Institution, Finsbury-circus, E.C., 5 p.m. Prof. R. S. Ball, "Some additions to our knowledge of Shooting Stars."
Social Science Association, 1, Adam-street, Adelphi, W.C., 8 p.m. Mr. Joseph Brown, "The Frauds of Promoters of Companies."

Tues. ..Royal Institution, Albemarle-street, W., 3 p.m. Prof. Garrod, "The Protoplasmic Theory of Life and its bearing on Physiology" (Lecture II.)
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Discussion on "Dynamo-Electric Apparatus."
Anthropological Institute, 4, St. Martin's-place, W.C., 8 p.m. Annual meeting.

Wed.... **SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Dr. Christopher Dresser, "The Art Manufactures of Japan."

Thur. ...Royal, Burlington House, W , 8½ p.m.
Antiquaries, Burlington House, W., 8½ p.m.
London Institution, Finsbury-circus, E C., 7 p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "Chemistry of the Organic World." (Lecture II.)
Philosophical Club, Willis's-rooms, St. James's, S.W. 6½ p m.

Fri.......**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Indian Section.) Sir Joseph Fayrer, "The Destruction of Life in India by Wild Animals."
Royal United Service Institution, Whitehall-yard, S.W., 3 p.m. Vice-Admiral E G. Fishbourne, "The Main Causes which lead to the Foundering of Ships."
Royal Institution, Albemarle-street, W., 8 p.m., Weekly Meeting. 9 p.m., Mr W. H. Preece, "The Telephone."
Geologists' Association, University College, W.C., 8 p.m. Annual Meeting
Philological, University College, W C., 8 p.m. Mr. W. R. Morfill, "The Bulgarian Language, with special reference to the Palæo-Slavonic."
Archæological Institution, 16, New Burlington-street, W., 4 p.m.

Sat.......Working Men's Club and Institute Union (at the House of the Society of Arts), 4 p.m. Lecture by Sir George Campbell, "India"
Physical, Science Schools, South Kensington, S.W., 3 p.m. Annual Meeting.
Royal Institution, Albemarle-street, W., 3 p.m. Mr. R. Bosworth Smith, "Carthage and the Carthagenians." (Lecture II.)

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,315. Vol. XXVI.

FRIDAY, FEBRUARY 1, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

TECHNOLOGICAL EXAMINATIONS.

The Council have determined to add Telegraphy to the list of subjects in the Society's Technological Examinations.

The syllabus for the use of Candidates is now being prepared, and will be issued shortly.

The first examination will be held in May next.

Mr. W. H. Preece has undertaken the duties of Examiner.

ADDITIONAL LECTURES.

The first lecture of the course on "Explosions in Coal Mines," was delivered by Mr. T. Wills, F.C.S., on Monday evening last, at eight o'clock. The lectures will be published in the *Journal* later on, probably during the Easter vacation. The remaining lectures of the course will be given on February 4th and February 11th.

HEALTH AND SEWAGE OF TOWNS.

The following correspondence has taken place between the Secretary of the Society of Arts and the Registrar-General of Births and Deaths:—

Society of Arts, 19th December, 1877.

Sir,—I am directed by the Special Committee of this Society, in charge of the above subject, to ask whether, in giving the weekly death-rates of sundry large towns, a subdivision could not be made so as to show the death-rates in certain districts of such towns.

The deaths, taken as a whole, in any town, may present a fair appearance, whereas there may be, as we know there are, districts where the death-rates disclose a very unsanitary state of circumstances.

It would be well, if possible, to draw public attention to such state of thimgs.

The Committee venture to make the above suggestion, in the hope that it may be the means of promoting sanitary progress.—I am, Sir, your obedient servant,

(Signed) P. Le Neve Foster, Secretary.

To the Registrar-General,
Somerset house, W.C.

General Register-office, Somerset-house,
4th January, 1878.

Sir,—I have to thank the "Special Committee" of the Society of Arts for bringing under my notice the fact that the mortality in particular parts of large towns may disclose a "very unsanitary state of circumstances," although the deaths taken as a whole may present a fair appearance.

I have given that serious consideration in framing the plan of my publications. And you will observe that, although in my Weekly Return I give the deaths and fatal diseases of 20 large English towns without distinction of locality, I publish in the Quarterly Return the births and the deaths from all causes, distinguishing those from violence and from eight of the principal zymotic diseases, in 2,186 sub-districts. Take Birmingham as an average instance; the return is for the whole district and for its six several sub-districts, where the deaths range from 110 to 518 in the 13 weeks or from 8 to 40 weekly. The same detail obtains in my Annual Report.

I had before me a plan for publishing the return for every sub-district in the kingdom weekly, but I did not adopt it—

1. On account of the cost of this extensive weekly publication.
2. On the ground that the weekly deaths in each sub-district would be liable to great accidental fluctuations.
3. On the ground that I have no means of distributing the deaths in the hospitals and workhouses over the sub-districts to which they belong.
4. On the ground that minute details, extremely interesting to the inhabitants of a town, would not generally obtain the attention of outsiders sufficiently to enable them to draw just conclusions.

The Committee is no doubt aware that the mortality of a year, or of five years, differs not only in sub-districts or parishes, but in streets to a large extent. And these local inquiries properly belong to the several urban and rural sanitary authorities, who are bound by law to appoint medical health officers, whose duty it should be made to conduct local inquiries, and to publish weekly returns, at their own expense.

As far as I am able, I give the local authorities every facility for obtaining, on the most moderate terms, all the information the local registrars can supply.

The Society might, I venture to suggest, do good by addressing the requests they have made to me to the local sanitary authorities or health officers of the great towns.—I have the honour to be, Sir, your obedient servant,

(Signed) George Graham, Registrar-General.

P. Le Neve Foster, Esq., M.A., Secretary,
Society for the Encouragement of Arts, &c.

Society of Arts, 19th January, 1878.

Sir,—I am directed by the Special Committee on the Health and Sewage of Towns to acknowledge the receipt of your letter of the 4th instant, and to express to you their thanks for the information you have been so good as to favour them with.

The Committee direct me to ask whether they may be permitted to publish the letter in the Society's *Journal.*

The Committee highly appreciate the valuable suggestion you make for their addressing themselves to the local sanitary authorities or health officers of towns, but they are of opinion that perhaps in the first instance the object would be more likely to be attained if your office could direct the officers of, say, the twelve largest towns, to supply to the local registrars the statistics of the highest and lowest rates of mortality, and that the registrars be instructed to send that information to the Society of Arts weekly for publication in its *Journal* as an experiment.—I have the honour to be, Sir, your obedient servant,

(Signed) P. Le Neve Foster, Secretary.

To the Registrar-General,
Somerset-house.

General Registrar-office, Somerset-house,
23rd January, 1878.

Sir,—In reply to your letter of the 19th inst., I have to state that I shall be very glad to see my letter of the 4th inst. published in the Society's *Journal*, if it be thought worthy of being so placed.

With respect to the suggestion in your letter which the Society are good enough to make, I will thank you to apprize them, that it shall have my best consideration.—I have the honour to be, Sir, your faithful servant,

(Signed) George Graham, Registrar-General.

To the Secretary, Society for Arts, &c.,
John-street, Adelphi, London.

CANTOR LECTURES.

THE TECHNOLOGY OF THE PAPER TRADE.

By William Arnot, F.C.S., Edinburgh.

Lecture VI.—Delivered Jan. 21st, 1878.

The various classes of Paper: characteristic differences. The determination of the Ash or Loading. Water Supply. General Arrangement and Construction of the Mill.

The almost endless variety of purposes to which the material is now applied involves the production of papers differing very widely in colour, texture, and strength. For bank notes and deeds of various kinds we must have paper that will stand much tear and wear, while for newspapers, which are now considered old twenty-four hours after publication, a paper indifferent both as to strength and colour will be quite suitable. We must have strong, heavy Manilla papers for wrappers and bags, and light, airy tissues to be applied to such varied purposes as making letter books, wrapping up silver plate and jewellery, and for decorations of various kinds. We must also have satin cream-laid note for writing our missives upon, and bibulous paper for blotting and filtering. I do not know that we need go very fully into this subject. We have much ground to cover in this our last lecture, and we must try to apportion our time to the various subjects to be discussed proportionately to their importance.

The papers in every day use may be classified in various ways. For our present purpose it will be sufficient to look at them as divided into four groups:—(1) printing papers, (2) writing papers, (3) wrapping papers, and (4) miscellaneous papers. The first group comprises about one half of the entire paper manufactured, and of course includes products widely differing in their nature. Beginning with newspapers, we have a variety of fabrics into the composition of which may enter esparto, straw, and wood. Made from all esparto, carefully beaten out, and not too heavily loaded, the product may be considered quite equal to all the requirements of a first-class newspaper. Mixed with, say, 7 to 10 per cent. of wood fibre, or 10 to 15 per cent of straw, esparto will give a fairly good paper for the ordinary run of newspapers, while with larger proportions of wood or straw the strength of the sheet will diminish. Straw and wood by themselves do not give strong papers, but still they are produced and consumed in considerable quantities. The amount of clay introduced will also materially influence the character of the product. A paper made from a short, hard fibre, and heavily loaded, may be considered at the bottom of the scale, both as regards strength and flexibility; the mere look of the paper may be good enough. Next to newspaper papers come common and medium printings, they are intermediate in character between newspapers and fine printings, and are of almost endless composition and tone, to suit the views of the printer and his clients—the element of cost always being prominent. They rarely contain anything of a nature stronger than esparto, and perhaps a little jute. Fine printings are more carefully prepared than the other varieties we have spoken of, the bleaching, pulping, toning, and straining being all very carefully attended to, and the strength of the fabric increased by the addition of from 5 to 10, or even 20 per cent. of strong rags. The beauty of the texture of some of these papers is admirable, and, perhaps more than any other class of machine-made papers, illustrates the perfection to which the art has been brought. It is comparatively easy making beautiful papers when a long price can be got for them, such as will enable the manufacturer to use the finest materials obtainable, but it requires skill and experience to produce the admirable specimens I speak of with comparatively worthless materials, and at small cost. The cotton or linen rags to be blended with the esparto are put into the beating engine as bleached half-stuff, and the two materials are beaten up together. The effect of even 5 per cent. of linen upon the character of esparto paper is very noticeable, especially as conferring a considerable degree of strength to the sheet.

In the second group we have writings of all kinds, divisible at once into engine-sized and tub-sized machine-made, and hand-made. The first-named variety differs but little from fine printings, and is produced to meet the popular demand for cheap goods. Engine-sized writings may contain a larger per-centage of rag stuffs than printings, and are more heavily sized, as well as more highly calendered. They are generally coloured, too, to meet the taste of the consumer. Tub-sized writings embrace a very large variety of papers, differing in texture, weight, colour, and marking. Among them we have some of the most beautiful products of the paper-maker's art—made from the finest, whitest, and strongest of materials, beaten so as to retain all their good qualities—strength, flexibility, and elasticity—uncontaminated with mineral matters, beautifully and appropriately water-marked, and surfaced to perfection. In recent times I have been struck with the close resemblance which many of our better qualities of machine-made writings bear to hand-made papers, and it seems to me that, with skill and care, and the same quality of raw materials, machine-made papers need not be far behind the undoubtedly fine product of the hand mould. The better classes of tub-sized writings are produced from various admixtures of cotton and linen fibre. Some of them contain a small percentage of clay or pearl hardening, others starch, either introduced dry or swelled with boiling water, or both agents may be present along with whatever colouring matter may be required to give the paper the requisite shade or tone. Hand-made writings are always of a high quality, made

as they are for those who can appreciate and pay for an unexceptional article. The fibres are drawn out so as to retain as much of the original length as possible, and the peculiar shake which the experienced vatman communicates to the mould causes these to interlace into a strongly felted sheet. Messrs. Hodgkinson and Messrs. Spicer have sent me some specimens of hand-made papers which are simply faultless, while Messrs. Cowan Allan and Annandale have handed me an extensive collection of their machine-made writings, which very well illustrate the remarks I have just made. Account-book papers belong to this group, and differ but little, unless in thickness and shade, from the writings we have been speaking of. Much of the paper used for this purpose is yet made by hand. Artists' papers may also be considered under this head. Complaint has been made that papers cannot now be got that are absolutely trustworthy for high-class work. It is, of course, a serious matter for the artist to find, after he has spent much time and labour in developing his ideal, that the sheet upon which he has been working has lost its flatness and its surface, and is no longer the thing of beauty which it appeared to be. I am inclined to think, however, that if paper ever was produced with all the qualities desired, it can still be produced, and that probably the prevailing cry for cheap goods has not been inoperative in even this department of the trade. I have placed myself in communication with the Messrs. Hodgkinson upon this subject, and these gentlemen assure me of their readiness to consult the views of the profession, and undertake to produce paper that will meet all the requirements of the artist, if some experienced gentlemen will kindly communicate with them, and point out what their wants really are.

The third group embraces papers of the most widely different characters, from the thinnest of caps to the heaviest manillas. The variety here is indeed endless, such as to defy even a passing reference to the various classes in the short time at our disposal. Ropes, manilla, jute, and flax waste enter largely into the composition of the stronger and heavier classes, such as cartridges, manillas, hosiery, &c., while sedges, palmetto leaves, rough grass, straw, and esparto figure in the lighter and weaker classes. Clay plays an important part, too, in the composition of some of the cheap, heavy papers; and various colouring matters added to all the classes multiply the varieties very greatly.

In the fourth group is embraced all the varieties of coloured and fancy papers, and to these certainly one entire lecture might be profitably devoted; I must for the present, however, leave them untouched.

Boards, which can scarcely be included in any of the groups, are used for a variety of purposes, probably most largely for binding books. The raw materials used in their manufacture are of the coarsest kind, indeed what all other mills reject can be readily used up in the board mill. The machinery involved is much less elaborate than that used in producing paper. The finest boards are still made on moulds by hand, but the great bulk of them are produced on machines resembling the wet end of the Fourdrinier or the "cylinder." The raw material is not usually boiled at all, but is at once put into the engine. The stuff, after being beaten—and of course that is an operation that is not carried very far—is run direct into stuff chests, and from these on to the wire of the machine, the refinement of sand-traps and strainers being dispensed with. The board is not made at once by the simple draining of the stuff upon the wire, as paper is, but is made in layers. Stuff of the thickness necessary to produce boards of medium thickness would never drain upon a wire, or cylinder, and could not well be made uniform with the rough materials used; the sheet is, therefore, run out very thin, so as to form a sheet something like good, strong brown paper, and this, after passing between the press rolls, winds upon the upper one—which is usually of wood—until a sufficient thickness has been attained, when it is slit up and removed from the roll. The various layers, being pressed into each other while quite wet, adhere, and form one solid sheet, or board. The roll round which the boards are formed, is grooved in several places longitudinally, the grooves serve to guide the knife used to slit up the cylinders as they attain the desired thickness. As the sheets are removed from the roll, they are, of course, curved, but are easily pressed out flat upon a table. They are then made up in piles, alternated with felts, and squeezed in the hydraulic press until the bulk of the moisture has been removed. The drying which follows may be accomplished in three ways, either by the air, or on steam-heated plates, or in kilns; or the air process and either of the others may be combined. When they are to be dried by the air they are either laid out upon grass plots or put up in racks. Of course this is a very slow process, and, unless in very small establishments, quite inapplicable. Steam drying is more rapid, but it is also more expensive. Kilns or stoves are just hot air chambers, in which the boards are arranged in racks. The drying is done rapidly in these, and if care be taken to prevent the temperature rising too high, the results are satisfactory. The boards have finally to be calendered, the rolls by which this is done being heated by steam, which enables them to impart a much higher surface to the goods than they would if cold. Before subjecting the boards to the pressure of the calenders, however, they have to be steamed for a few seconds to soften them a little; in fact, the steaming and hot calendering are exactly analogous to the damping and ironing of linen.

We have now to consider the method of estimating the amount of ash or loading in paper. In all well-conducted establishments this operation is now very frequently conducted so as to control the use of loading matters in the mill. Paper-makers, as a rule, quite realise the importance of this, and we are convinced that in many other departments of the trade equal vigilance would be equally repaid. The following apparatus is necessary for the successful and rapid execution of the process:—A balance weighing to tenths of a grain, a platina capsule, about $2\frac{3}{4}$ inches in diameter by $1\frac{1}{8}$ inch deep, a tripod and pipe-clay support for the capsule, a pair of small tongs to lift it with, a piece of platina foil to direct the hot air into the capsule, a piece of brass wire rounded at the ends, and a good $\frac{3}{4}$-inch Bunsen burner. The operation in itself is exceedingly simple. 50 grains of the sample torn into small pieces are weighed and

placed in the capsule; a convenient way is to balance the capsule in the scales, and weigh the paper in it. The capsule and its contents are then placed upon the support over the burner, the flame of which must be controlled so that it will be quite smokeless. By canting the capsule a little, and placing the platina foil over it, so as to cause the flame and hot air to play amongst the fragments, the carbon will be burned off much more quickly than when it is left open. An occasional stir with the end of the brass wire will expose fresh portions of the ash to the oxidising action of the current. The burning should be thoroughly effected in from ten to fifteen minutes. After the capsule has been allowed to cool completely, it may be placed, with its contents, on the balance, and the weight of the residue ascertained; this, multiplied by two, will give the per-centage quantity of mineral matter. Allowance will, of course, be made for the normal ash of the paper. The ash, as a rule, will be quite white, but, depending upon the composition of the paper, it may either be grey or reddish. A good supply of gas should be provided for the burner, or the work will be tedious.

The character of the water-supply of a mill very largely influences the character of the paper produced; of course, I do not refer to any water that may be available for power, but to that which is essential for washing and diluting the pulp. To be in every way suitable for the production of the finer classes of paper, this water should be quite bright and colourless, free from all visible impurity, and free also from the dissolved chemical impurities—lime and iron. It is but rarely that we meet with water possessing all these qualities in a high degree. If the supply is obtained from a stream, it may be contaminated with colouring matter derived from vegetable sources, and at certain seasons it certainly will be impure from mineral and other matters washed into it by the rain. To ensure a constant supply of known quality from such a source, a reservoir and filter will be necessary. The former should be large enough to contain as many days' supply for the mill as experience has shown necessary to tide over the periods during which the flood water is seriously impure. If the normal condition of the water supply is such as to involve constant filtration, then the filters must be extensive, and so arranged that a portion of the system may be cleaned out at any time, while the remainder is kept at work. For every 1,000 gallons of water required per 24 hours you must have a filtration area of from one to one and a half square yards. The most suitable materials are sand and gravel arranged in three or four layers, fine washed sand forming the upper stratum. Drain-tiles will, of course, be laid pretty thickly in the bottom; and it is advantageous to have a few vertical air-pipes communicating with the drains; these are especially serviceable when running the water on to the filter for the first time. But the water may be quite free from colour and suspended matters, and still be but ill-suited for the purposes of the paper-maker. It may be hard, or alkaline, from the presence of lime salts, which will re-act with the chemicals used at all the stages of the process, detracting from their effect, and involving the use of larger proportions than would otherwise be necessary. Of course, the extent of this effect may be but slight, but, on the other hand, it may be serious, depending upon the proportion of lime in the water, and the volume of it used in the various operations. There is no good or readily available means of overcoming the difficulty. Chemical agents may be used to remove a portion of the lime and magnesia; but the use of them involves both labour and expense; and it is questionable if the cost will not in every case exceed the gain. When the evil is really a serious one, an effort should be made to collect surface water and apply it to those portions of the process where soft water is most desirable. If the water is contaminated with iron, it will be quite unfit for pure white papers. The iron is precipitable from its solution by alkalies, and when so precipitated it cannot but affect the tone of the paper. Of course, the quantity may be—as, indeed, it usually is—almost infinitesimal, in which case it may be disregarded; but, if it should amount to anything like a grain to the gallon, its presence must be prejudicial. Hofmann, in his work on paper, says if water contains only one-fiftieth of 1 per cent. of iron it will be prejudicial. As there are 70,000 grains in an imperial gallon, the quantity referred to will be equal to about 14 grains per gallon. If such waters exist at all in the proximity of paper-mills, give them a wide berth, as they are utterly unsuited for any but medicinal purposes. Whatever be the nature of the supply or its source, it is always desirable to have a couple of days' supply ahead of the mill, in case of accidents. This will enable the pumps, necessary when the source of supply is low, to be overhauled from time to time. When the water is pumped direct into small supply cisterns, the failure of a pump becomes a serious matter. The quantity of water used per ton of fine printing paper produced should not exceed 40,000 gallons, and if the various precautions as to boiling, washing, and rinsing machine water which I have indicated from time to time be adopted, the quantity will be less than 30,000 gallons. Writings will take more, and the lower qualities less.

In the earlier days of the paper trade, water for driving purposes was considered indispensable, and, until comparatively recently, the idea of building a paper-mill away from water-power would not have been entertained. The development of our coal-fields and railway system, with the introduction of esparto and chemicals, have, however, completely changed the conditions of success. No doubt water-power is at all times an element of importance, but cheap coal, facilities for bringing the raw materials into the heart of the mill, and removing therefrom the finished product, coupled with an abundant supply of pure washing water, and a ready outlet for the impure, will go far to compensate for the absence of water-power, if it comes to be a choice between having the one or the other, and not both. The power necessary to keep a 100-inch machine mill going is about 250 horse-power; and no doubt if any considerable proportion of this could be got steadily from water, it would be valuable. Water at the best, however, is very fluctuating in amount; and a paper-mill perhaps above all other industrial establishments, requires a perfectly steady power. The steam necessary, independently of what may

be wanted to furnish or supplement the driving power, is considerable; and it will often be found that the lower price of coal at one place compared with another will be of more real importance than the existence or non-existence of so much water-power. This leads me to say, in reference to the selection of a site for a paper-mill that due regards must be had to the following among other matters:—The possibility of obtaining a copious supply of pure soft water; proximity of railways, and the possibility of getting a siding into the work; proximity of port for arrival of esparto; ready supply of good coal at cheap rates; skilled labour available, and house accommodation for the same; disposal of refuse matters, both solid and liquid, without the risk of interdict as a nuisance; and, if you will, available water-power. In constructing a paper-mill, the plan should be well considered, so that the various operations, including the moving of materials from one place to another, may be accomplished with the smallest expenditure of labour. It will be remembered that the materials in process of conversion into paper continually descend as they go forward in the mill. They are first put in at the top of the boiler, then discharged from the bottom, next put into the breaking engine over the lip and discharged from the bottom into the poacher, from the bottom of which they discharge into the hydraulic press. At this point there is usually a break in the gravitating process, hoists being used to lift the pressed half-stuff to the level of the beating engine; from the latter it discharges into the machine chests, and thence on to the machine itself. If this hoisting can be avoided, so much the better. It is seldom, however, that a site can be obtained where the whole process will go on without some lifting.

The buildings should all be roomy, with high open roofs, well lit and ventilated. It is a mistake to suppose that work can be either well or cheaply done in dark, confined, ill-ventilated apartments. A better class of workmen will grow up under the healthy influence of cheerful surroundings, than in the depressing atmosphere of a close, crowded, and untidy mill. The machine-house especially must be well ventilated, and this must be arranged in such a way that there will be no possibility of down-draught, the effect of which would almost certainly be to precipitate blacks and dust of all kinds upon the web, to its permanent detriment.

A large amount of vapour constantly arises from the paper passing over the drying cylinder, and unless this is speedily removed it will condense, and drop from all parts of the roof, &c. Various plans have been devised for the ventilation of machine houses, and some of them have, no doubt, proved very satisfactory. Boyle's ventilator, which works splendidly when there is a good breeze outside, does but little work when the atmosphere outside is still. The Archimedean screw ventilator has been extensively adopted, and gives great satisfaction, especially when driven by a cord from the mill shafting. This insures a constant suction, which would fail in calm weather—owing to the stoppage or slow motion of the screw —if the motion was dependent, as it is in the case of halls, and such like, upon the power of the wind to move it. Another system is to have a double ventilating shaft rising from the roof, with the louvre boards so arranged that soot and dust cannot be blown inwards.

The steam boilers should be situated having a regard to the easy access of fuel, and the points where the steam is most largely to be consumed. They should be of ample power, so that they will not require to be fired heavily. It is a great mistake, working with insufficient or indifferent boiler power, or with boilers that are not in first-class condition. Steady, careful firing in thin layers, in alternate furnaces, will give very economical results compared with heavy, reckless firing, conducted under the impression that, as the steam is difficult to keep up, the correct thing to do is to pitch on as many coals as possible. Let the quantity of smoke constantly issuing from the chimney-top speak to the absurdity of the practice, and also the blacks which a foggy day will inevitably bring down to pollute the product. Mechanical stokers are no doubt very good things, but they are only necessary when men and master are alike careless or ignorant of the principles involved in the combustion of fuel. The exposed portion of the steam boilers, as well as all the pipes leading the steam through the mill, should be coated with non-conducting materials, The sludge settling from machine and engine waters, mixed with a small proportion of rough fibre, makes a very good coating agent. The boilers should be blown down a few inches every shift, especially if the water is in any way hard; and they should all be insured, much more for the sake of the systematic inspection which that involves, than the securing of a few hundred pounds in the event of their blowing up.

Fires, unfortunately, are not uncommon in paper mills; provision should therefore be made so that, in the event of such an accident, the flames may be extinguished as rapidly as possible. This is all the more necessary when the mill is situated at a distance from public fire appliances. Fortunately, the existence of the mill itself implies the existence of an abundant supply of water, and arrangements should be made so that the whole of this may be readily available the instant fire is discovered. Force-pumps in various parts of the mill should have connections and off-takes for hose-pipes, so that, whatever their purpose usually, they may, by simply opening a few taps, at once begin to drive water wherever it may be required; a manual engine is also useful, as well as buckets, placed all over the mill, which should on no account be used for any other purpose. When it can be done conveniently, a very good plan is to have special water mains all over the mill, with numerous off-takes, and a full supply of hose pipes, the system being connected with a set of force pumps, worked by a little turbine, and drawing from the river.

The success or failure of a paper-mill will very largely depend upon its management. There is nothing that will so much contribute towards the prosperity of an industry of this kind as an energetic, progressive, and discerning manager, one who not only knows his work, but finds his chief pleasure in keeping both men and machinery moving sweetly; one whose mind is not a fossil, incapable of appreciating and yielding to altered conditions, but ever on the alert, seeking to develop and improve, and willing to accept improvements on fair evidence, even though the

ideas have not been born in his own mind; one who can be at home with his men and yet retain his position amongst them. He does not require to be a genius, but thinking, active, intelligent, and attentive; to such a man "brocke," and "retree," and "lost time" are hateful terms, and indolent and careless workmen a nuisance not to be tolerated. Such a manager should be appreciated and encouraged, and that their number may be increased, opportunity and encouragement should be given to intelligent young men to prepare themselves for such positions; they should be stimulated to study and attain a knowledge of the principles involved in the various parts of the industry, and to go forward to the Society's examinations until they have passed the "honours" stage. Young men holding certificates to that effect ought to develop into well-qualified managers.

In drawing this course of lectures to a close, I may mention that my attention has been called to a new method of working machine vacuum boxes which has been patented and applied by Messrs. Mason, Wolstenholm, and Spencer. The appliance is simple, consisting as it does of a steam jet acting as an ejector. This neat device takes the place of the usual pump, and is said to give very good results. The advantages claimed for it are, that it maintains a steadier vacuum, and allows of more water being run on to the wire with the pulp, the practical result being more uniform paper with less "brocke." I have no doubt at all as to the efficiency of the arrangement, it is simple in construction, steady in its action, and easily kept in order, but I suspect it will be found to consume a considerable amount of steam.

My attention has been directed to an interesting historical fact with which I regret I was not earlier acquainted, but which justice to the memory of one who virtually sacrificed both his fortune and his life in working out the appliances now in common use for surface sizing and drying, compels me before closing these lectures respectfully to notice. About the year 1842, Robert Gill Ranson, of Ipswich, invented and patented the appliances referred to. Previous to that time the endless web made on the Fourdrinier machine had to be cut into sheets before it could be sized and dried; the labour involved in so doing can be imagined. Since Mr. Ranson's death in 1843, the drying machine has no doubt undergone a great development, but both the sizing and drying machines of to-day are essentially those which Mr. Ranson left behind him, which is a testimony to the correctness of the principles which he set himself to work out.

I have also to express my indebtedness to many friends, both in England and Scotland, for kindly supplying me with specimens of their produce, and information as to their manufacture, and to others for invitations to examine their processes, which I regret it has been quite out of my power to accept.

Many questions of a technical nature—chiefly chemical—have been addressed to me since these lectures were announced, some of which I have replied to in the course of the lectures, but to others I have not been able to give satisfactory explanations, and for this reason, that the subjects, though of great practical interest to the paper-makers, have, so far as I can learn, never been properly investigated.

Among the subjects to which I refer, are:—First, the nature and origin of, and cure for quite a variety of specks and spots, some of which appear and disappear in the most unaccountable way. That, in some cases, the specks are due to the presence of the uncombined resin precipitated by acid aluminous cakes, I have little doubt; others, again, are clearly of an oily or greasy nature, while to many more it is very difficult to assign an origin. Of course, I do not refer to specks that are clearly traceable to ill-prepared fibrous substances, the origin of many varieties of such impurities is usually not difficult to trace. Second, what effect the sulphate of alumina or alum exercises upon the paper apart from precipitating resin-alumina—that is, supposing an excess of these agents to be used? As a rule, I find that excess—and in some cases very large excess—is used, and the most diverse accounts are given as to the reason of this and its supposed action. Some say it cleans the fibres, but I rather think the time for cleaning the fibres is quite gone by the time the alumina is usually introduced. Starch and clay and colouring matters have all been added in order that they might adhere to the fibre before the resin soap is introduced to coat them, and how after these and the soap itself have been added, a little sulphate of alumina can do anything analogous to cleaning I cannot guess. I would have it to be considered, too, that sulphate of alumina is extremely soluble, and that any such remaining undecomposed in the pulp as it goes down to the machine must be diluted along with the pulp, and all but the merest traces of it pass away with the water through the wire. Third, how best to preserve and clarify animal size? I understand that one or two makers know all about this, but choose to keep the information to themselves, which of course they have a perfect right to do, although it is somewhat contrary to the spirit of the age. Fourth, the great loss which some rags sustain in the boiling and bleaching processes, notwithstanding their being of almost pure cellulose? Apparently fine white linen or cotton should lose little or nothing by either process, yet we find, even allowing for the moisture and glutin, a very considerable reduction. Fifth, many questions concerning the re-use of machine and other waters, &c.

Such investigations involve much time and expense, and I am afraid will not be readily undertaken by competent men, unless paper-makers themselves combine to have the experiments carried to a satisfactory issue. The chemistry of the art is doubtless yet in its infancy; indeed, it is little more than half a century old, and although that period has been one of enterprise and inquiry, it cannot be said that in this, any more than in most other of our leading industries, much progress has been made in the way of elucidating the principles involved in the various operations. The pressure of the increased competition and lower prices of the last few years has, no doubt, led to some inquiry in various departments, with results which may be regarded as a foretaste of what might be expected to flow from an exhaustive study of the subject.

The mechanism of the paper process has under-

gone a more satisfactory development; ingenious engineers have improved the appliances to such an extent that there is apparently little further to be desired. We do not doubt, however, that many further improvements will be worked out as time goes on. The difference in the two departments—chemical and mechanical—is that, in the former improvements in the application of the agents supplied by the chemical manufacturer fall to be worked out by the paper-maker himself; the manufacturing chemist may improve his own process of production and cheapen the product, but he can do nothing more for the consumer. On the other hand, engineers devoting themselves entirely to paper-mill work strive to improve their appliances and meet the wants of the manufacturer as they arise. In short, in the chemical department of his profession, the paper-maker is left to make his own discoveries and improvements, whereas in the mechanical he has simply to indicate what his wants are, and forthwith unexceptional appliances are provided for him. That the chemical operation of a paper-mill should be as well understood and under as complete control as are the mechanical operations there is no room to doubt, and as time advances, this will be more fully realised and given effect to.

My attention has been drawn to the circumstance that in my third lecture I have transposed the speeds of the breaking and beating engines.

EIGHTH ORDINARY MEETING.

Wednesday, January 30th, 1878; Sir RUTHERFORD ALCOCK, K.C.B., F.R.G.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Brooke, Captain W. Saurin, Bilaspur, Central Provinces India.
Grantoff, Albert, 17, St. Swithin's-lane, E.C.
Lenglet, Amand, 38, Finsbury-circus, E.C.
Skinner, Thomas, Naunton-villa, Carleton-road, Tufnell-park, N.

The following candidates were balloted for and duly elected members of the Society:—

Ashwell, William Henry, Argyll-house, Bedford.
Barkworth, Thomas, Chigwell, Essex.
Beeman, Joseph Samuel, 182, Earl's-court-road, Kensington, S.W.
Bell, Matthew, Temple Works, Cursitor-street, Chancery lane, W.C.
Bowdler, Arthur Clegg, F.C.S., Church, near Accrington, and 20, Wellington-street, Blackburn.
Brunton, R. Henry, F.R.G.S., F.G.S., 1, Oxford-villas, Balham, S.W.
Cook, Mr. Alderman Joseph, Mayor of St. Helen's, Lancashire.
Dale, Edward Robert, Glanville's Wootton, Sherborne, Dorset.
Fergusson, William, Gas Works, Neepsend, Sheffield.
Fung Yee, Mandarin, Interpreter to Chinese Legation, 45, Portland-place, W.
Garrett, Frank, Aldringham-house, Saxmundham.
Grieve, Thomas Kerr, Boston-road, West Dulwich, S.E.
Hamilton, Major Alexander, R.E., Aldershot.
Harris, C. J., 11, Kilburn-priory, N.W.
Howard, John, F.R.G.S., Topsham, Devon.
Marsland, James, 5, Three Crown-square, Borough, S.E.
Ménier, A. S., 153, Minories, E.C.
Otway, Arthur, 19, Cromwell-road, S.W.
Patzor, Robert Frederick, Stoke-on-Trent.
Smith, W. Shore, 30, York-place, Portman-square, W.
Tyacke, Richard T., Sir W. C. Trevelyan's School, Seaton, E. Devon.

The paper read was—

THE ART MANUFACTURES OF JAPAN, FROM PERSONAL OBSERVATION.

By Christopher Dresser, Ph.D., F.L.S., &c.

It was in the year 1862 that I first formed an acquaintance with Japanese art, your Excellency, my chairman, having in that year brought together a number of objects from this strange country, such as were then altogether new to us. In this collection were bronzes, pots, vases, fans, fabrics, ivory carvings, works in straw, lacquer, silver, wood, and many other materials; and the objects were both new and old.

I need not tell your Excellency that you have the honour of having first made Japanese productions known to the English public, but this I would say, that the love for such objects as your Excellency first showed us in 1862—a love which was through you kindled in our midst—has steadily increased to the present hour; and I firmly believe that the introduction of the works of Japanese handicraftsmen into England has done as much to improve our national taste as even our schools of art and public museums, great as the good which they have achieved is: for these Japanese objects have got into our homes, and amongst them we live.

This appreciation of the manufactures of Japan is common to all persons of cultivated taste. Artists love these works, and admire them with an earnestness akin to reverence, and I am happy to be able to tell you that their Royal Highnesses the Prince and Princess of Wales, by the refinement of their perception, as fully appreciate the art qualities of Japanese objects, and as sincerely love their excellencies as though they had spent their days in an artist's studio instead of amidst the alluring splendours of a palace. I only hope their Royal Highnesses as fully feel, as I do, the value of their royal patronage. With it any art will progress; without it the most noble of crafts may perish. The interest which is taken by their Royal Highnesses in the beautiful works from Japan will do more than I can tell you for the advancement of good taste in our midst.

You, Sir Rutherford, first gave me a love for Japanese art. You first showed me what works Japan could produce. In 1862 you kindly permitted me to make sketches of whatever you possessed, and I made about 80 drawings, such as they were, in the Exhibition from the various articles which you brought over, and at the close of the Exhibition, through your goodness, I became the possessor of a fair selection of the objects which formed your interesting collection; and to the treasures which I thus became possessed of I have almost constantly been adding, till now my house is now rather a museum than a comfortable abode for civilized beings, at least, so says my wife. Feeling the beauty of these Japanese objects I have done what I could to encourage their introduction into this country, but especially have I concerned myself with the

introduction of the more beautiful, and the more rare art works, such as have been produced by the great artists of the country. Some few years since I proposed to Messrs. Charles, Reynolds, and Co., who have long been known as enterprising City merchants and importers of fancy objects from every corner of Europe, and who already brought to England much of the common manufactures of Japan, the establishing of a new business in a separate warehouse, and the importing, not only cheap objects from the far east, but also the rarest and most beautiful of works, and I further suggested that they use every effort consistent with business success to import only such objects, whether cheap or expensive, as have art merit.

The three partners, Mr. Charles, Mr. Reynolds, and Mr. Pare, adopted my suggestions, and with the energy that characterises all they do, established the now well-known business which trades under the style of Londos and Co. in the Art City Warehouses, 126 and 127, London-wall.

At first one warehouse only was taken, but within two years of the establishment of the business, a second was added, and now a third serves as a store-room for fresh importations; and Londos and Co. have branch houses in the various ports of Japan, China, Persia, and Morocco, and are probably the largest firm in Europe that concerns itself almost exclusively with the importation of art objects; but as comparisons are odious, and as there are other excellent importers, I will not insist upon its claim to the first place, but would simply leave it to individual judgment. Remember, however, that Londos and Co. are *boná-fide* importers, and that they not only are strictly wholesale in their dealings, but that they refer small retailers to Charles, Reynolds, and Co., of Milk-street, where there is also an assortment of the cheaper kinds of Japanese goods.

The desire to possess Japanese objects arose as soon as the International Exhibition of 1862 was open, and it was not long after this time that our merchants began to concern themselves with the introduction of these strange manufactures as articles of commerce, yet I read in the beautiful work on "The Keramic Art of Japan," by Messrs. Audsley and Bowes, that "Europe, comparatively speaking, knew but little of the subject of Japanese art prior to the Paris Exhibition of 1867." I admit that there was a glory about this exhibit which was made under the Shogoon's rule (being prior to the revolution of 1868), such as cannot be expected from the present Government who, seeking to secure to the nation rapid advancement, have overthrown pageantry; yet that these gentlemen should make such a statement, and entirely ignore your Excellency's valuable and large collection is strange, for the intelligent interest which both Messrs. Audsley and Bowes take in the artworks of Japan is scarcely surpassed by that of any person in this country.

Prior to the establishment of the firm of Londos, Messrs. Charles, Reynolds, and Co. had asked me to become their art adviser, an office which I gladly accepted, as I saw they were earnestly trying to bring to our market more artistic objects than had hitherto been introduced, and I have the honour of still holding this office in relation to Londos and Co.

The more I saw of Japanese art the more I wished to visit Japan, till finally I determined to start. Messrs. Londos and Co. at once arranged with me that I make for them, during my journeyings in that country, a typical collection of art objects such as should illustrate as fully as possible both the present and the old manufactures of Japan, and have reliable tutorial value, and Messrs. Tiffany, of New York, arranged with Messrs. Londos and Co. that I make a similar collection for them; but for Messrs. Londos and Co. I also agreed to write a report on the manufactures of the country, giving my opinion as to the capabilities of Japan for producing quantities of objects and wares, such as should be useful in our every-day life. With such a mission before me I was about to start. My excellent friend, Mr. P. C. Owen, C.B., now came upon the scene, and, with his usual desire to help everybody, told me of the great loss which the Japanese had sustained by the wreck of the vessel in which was stored the valuable collection of objects so judiciously made by His Excellency the Hon. Mr. Sano (the Japanese Commissioner to the Vienna Exhibition), and suggested that I get together specimens of our English manufactures, for presentation to the Japanese Museum in Tokio—the intended destination of the purchases so unfortunately lost. I did as Mr. Owen suggested, and, through the generosity of Messrs. Minton, Doulton, Green Nephews, Elkington, Ward and Cope, Jeffery and Co., Jno. Brinton and Co., Mr. Jno. Lewis, and Londos and Co., I had, together with some beautiful plates which the South Kensington Museum presented, a valuable vase, which Mr. P. C. Owen himself furnished, and 60 drawings which I was permitted to add to the collection—a somewhat interesting and valuable present to ask the Japanese Government to accept.

All was now ready for my departure. Messrs. Londos and Co. had collected and packed all the presents, and, through the kindness of Mr. Owen, a catalogue was prepared in the museum of which he is the director, and this catalogue was printed by Messrs. Londos and Co., and several copies were sent with the things.

On the 6th October, 1876, I left Liverpool for America, which I reached, and then tarried in, for a short time; and from there I was accompanied by General Saigo, the head of the Japanese Commission in Philadelphia, and his excellent staff to Japan, where I arrived on the 26th December, or about thirteen months since.

I now presented my credentials, and delivered up my treasures; and I need not tell you of the kind spirit in which the things were received, and of the gratitude which the Japanese were ever expressing by words and deeds for the gift, which they appeared most fully to value; and, in passing, I may say that I am now engaged in getting together samples of as many of our manufactures as I may be able to collect as a further gift to their museum; and for any assistance I shall be truly grateful.

While the Japanese Government were making arrangements for me to travel in their country I had the honour of spending a fortnight with his Excellency Sir Harry Parks, to whom and to Lady Parks I owe a deep debt of gratitude for many acts of kindness; and I should here also mention Mr. and Mrs. Mountsey, and the Hon. James Saumarez, as others who proved themselves sincere friends.

Those who know the Japanese will appreciate the statement, which I can conscientiously make, that, as far as my experience goes, they are the kindest people on earth, hence you will not be surprised when I say that I received every possible kindness from them during my stay in their country. Day after day, the Hon. Mr. Sano, who is much interested in the development of Japanese manufactures, took me to the various workshops, and his excellent secretary, Mr. Asami, was ever interested in giving me the information that I needed. On the 12th January, 1877, I was received by the Minister of the Interior. On the 20th January I had audience of his Majesty the Mikado, who was graciously pleased to order that his own private collection of antiquities be opened to my inspection—a collection which was catalogued over a thousand years back, and which has only once been exhibited, and then only in part, either to natives or Europeans; this exhibition having taken place about three years since.

On Saturday, the 26th January, I left Yokohama for Kobe, having spent a month in Tokio in studying the manufactures of that district, and in getting together such part of the representative collection which I had engaged to make as the capital and its surroundings furnished; thus I commenced my journey of nearly two thousand miles in the interior. From Kobe my first excursion was to the island of Owaji, which island I first reached, and then crossed in order to see the potteries which have, for two generations, carried on a sort of independent life in this isolated situation; and here I may mention an experience which serves to show one of the numerous difficulties of dealing with Japanese manufacturers if we call upon them to meet our wants as we expect European manufacturers to meet them.

Seeing a cup and saucer, with which I was well pleased at one of the Owaji factories, I asked that two complete tea-services be made for me of that particular pattern, and remarked that if they could get one made so that I could see it before I left the district, I would then, should it be satisfactorily manufactured, order others. After many and tedious calculations, with the aid of an abacus (that miserable frame, without which no Japanese trader can tell you the price of a penny toy), the manufacturer stated that he thought they could get the two services made in two years. In vain did I try to induce the owner of the factory to employ further assistance. "How," he said, "can I know that the work of other artists will please you," and my warmest assertions that if he were satisfied I should be pleased availed nothing, and I left him with the promise that in two years I should receive two services. Upon returning to the main land I started for Sanda, where celadon, or sage-green wares, have for many years been made. It is an outlying, mountainous district, in which I found small potteries loosely scattered over a considerable area. Next I went to the sacred city of Nara, then to Osaka—a great seat of metal and other industries, then to Kioto, and Lake Biwa, next along the entire length of the great promontory of Isé, where are situated not only the great Shinto shrines, but also the seats of the leather-paper manufacture. I then went to Nagya, then Wakiyama, then Koya-Zan—this latter being a sacred mountain, on which stands a city, formed of two hundred and forty temples, and which no woman entered for a thousand years prior to the revolution of 1868; and to this hour not even a Japanese can sleep in the city without a special order from the governor of the province. Yet, with the kindness which I ever received while in Japan, I was permitted to tarry with the priests in the sacred apartments of a temple.

To enumerate the various towns that I visited, and districts through which I passed, would occupy the entire evening; and I have mentioned the few just named in order to show you that I had the opportunity of observing the same manufactures in various parts of the country somewhat widely apart, but in all parts the manufacturing processes were similar.

Nothing impressed me so much, as the result of my observations in Japan, as the smallness of everything. The pottery of Owaji was large in comparison with most of the manufactories that I saw, yet it could only turn out one decorated tea-service a year. Generally speaking, one man constitutes the entire manufacturing staff of a factory, or, if he is an old man, the father and son.

I visited, while in Japan, sixty-eight potteries, and the most interesting wares were generally made in the following way:—In a lovely little room, the floor of which was covered with mats, dwelt the potter. I may tell you that in a Japanese living-room there is not one particle of furniture—no chair, no table, no cabinet. The floor is covered with thick mats, each of which is six feet by three (their foot and their yard are each of the same length as ours, but the inches are longer, as there are but 10 inches to the foot, and every room in Japan is of the size of a certain number of mats). One mat being removed from the floor, a potter's wheel is exposed to view, but the wheel is of the simplest character, as it is a mere circular stone of the form of a Cheshire cheese, level with the uncovered floor, and working on a vertical axis which is fixed in a log of wood beneath the floor. At one side of the wheel is a clean tray bearing a lump of clay. At the other side is another tray—often well lacquered, on which the vessels, when shaped, are placed. The operator now kneeling in front of the wheel, and sitting more or less back on his heels, sets the disk in motion by whipping it with the tips of his fingers till the necessary speed is attained in its rotations. He now places a piece of clay upon the wheel and gives to it form in the usual manner, stopping to whip the stone whenever it is necessary that its speed be re-quickened, and in this way he shapes his wares.

Not unfrequently the potter, after removing from the wheel the vessel which he has formed, distorts its shape, substituting quaintness of contour for a symmetrical form, and in the pottery district of Mino I found one man who was known under the cognomen of the funny man, as he invariably gave to his wares excentricity of character. Few in Japan can afford to burn their own wares, hence a number of potters congregate around a public kiln where their wares are fired at periodical intervals. In many cases, a potter only makes plain wares, when he sells his productions to artists, who not unfrequently reside at great distances from the potteries (nearly all the enamel blue ware is painted in Tokio on vessels made in Seto, about 300 miles distant). In this case the

artist usually keeps a stall, or little shop, and paints his wares, and attends to customers, as necessary. Such a man fires his own paintings in a kiln about 18 inches high, and 15 inches in diameter, the kiln being circular and having a domed top.

Having painted a sufficient number of pieces the kiln is charged, and the small charcoal fire by which it is to be heated is lit; but the potter not only lights the fire of his kiln but he also lights his pipe, and this he recharges about every three minutes, for it is very small; he now sits, the very picture of happiness, till his wares are fired. In this way things are managed in Japan, and while there are potteries with more pretentiousness to be found they are of rare occurrence, and where anything approaching European ideas has been adopted, excellence of execution is replaced by slovenliness, and the desire for gain supplants love of the work. Yet there are factories in which quantities of household vessels are made.

I visited a town which was devoted to the production of curious scarves and fabrics; and formerly the productions of this district were of the highest merit and interest. Here are some of these scarves, and in this way they are made. Two pieces of white silk-crape are taken, each of which is about three yards in length and twelve inches in width (twelve inches is the usual width of native cloths). These two pieces of fabric are placed together so that one is exactly over the other; thus placed we will regard them as forming one double fabric, and will forget that there are two thicknesses, for they are both treated as one, and the two are manipulated together, so as to effect a saving of labour. A small piece of pointed stick, resembling a common meat skewer, and a quantity of waxed thread, are the requisites of the process.

From below a small portion of the fabric is pressed upwards on the point of the skewer into the form of a little cone of, say, half an inch in height—a cone which is kept in form by the waxed string being wrapped around it; the skewer is now withdrawn and removed about half an inch from this little tuft, when it is employed to raise a second cone, which in its turn is wrapped round by the waxed thread. This formation of little tufts is repeated till the entire fabric is covered with them when it is ready for dyeing. Thus prepared, the fabric is taken to a dye vat (a vat which in this case generally contains scarlet or pink colouring matter), and here it is dipped. The action of the dye is, at the same time, to give colour to the cloth and to shrink it, hence, where the dye has come in contact with the crape a shrinking has taken place, thus permanent conical eminences are formed. The waxed thread is now removed, each little tuft being unwound, and not only has a curious fabric been formed, with a surface consisting of conical eminences, but also a fabric which is variegated in colour, for where the wax thread was in contact with the crape the dye could not act upon it, thus, by the one operation a fabric is produced both variegated and of a rich coarsely granulated character.

These scarves were, when single, worth about one pound sterling each. They were then such as any lady in the land might covet; but to ourselves in part, and still more to the Americans, attaches the blame of bringing comparative ruin to the town where they were made, and of destroying a lovely manufacture. "I will give you 18s. each for them." "I will give you 15s." "I will give you 12s.," and so on. This is what the consecutive foreign merchants said, till the last gave about 3d. Let me show you what this lovely manufacture has degenerated to; and these miserable fabrics are the best that can now be procured at the town where once only beautiful objects were made.

We talk, your Excellency, of the degeneracy of Japanese manufactures but who is the cause of this sad falling off in the quality of their productions? and we wonder whether Japan can now produce what it did prior to the overthrow of the Shogoon's rule. I am happy to tell you that Japanese arts are not yet lost, and that Japanese love of the beautiful has not been stifled, for in all cases where I offered remunerative prices I got the old thing with its beauties and strange merits. But as we are thus destroying the beautiful arts of a people saturated with the refinements which spring only from an old civilisation, can we wonder at that dislike to the foreigner which permeates so much of Japanese society? I do not; and were I a Japanese I should hate the foreigner with a sincere and unmitigated hatred.

This process of tieing the cloth into knots is used as a means of placing a spot, or curious pattern, on fabrics, not only in Japan, but also in India, and the silk pocket-handkerchiefs which were in common use by gentlemen about thirty years since, were spotted in this way. Here is a specimen from India showing the nature of the process.

While speaking of fabrics, let me try to describe to you various processes which I witnessed in one of the largest print-producing establishments in Japan; and what struck me as remarkable here was that most processes consisted in the combination of hand work and of mechanical methods.

First, I saw blocks which worked in pairs: the one was simply a heavy piece of wood with a perfectly smooth surface, the other had the pattern which was to be placed on the cloth cut into it; thus the figured block had the pattern wrought in intaglio upon it. From the deeper portions of the intaglio figure holes were bored through the block to its outer surface, where they were enlarged into funnel-shaped tubes.

In order that the fabric be figured, it is stretched over the plain block, which has its smooth side upwards. Upon this lower block the figured block is inverted, hence the fabric lies between the smooth surface of the plain block and the figured surface of the upper block. Pressure is now employed so as to bring the surfaces of the two blocks as near to each other as possible, and a dye is poured down the funnel-shaped holes and thus comes in contact with the fabric wherever the block is engraved. When the fabric has become saturated with the dye the blocks, while still in close contact, are inverted, so that the surplus dye is poured off, and the fabric has received its pattern; for the pressure has been sufficient to prevent the "running" of the dyes, and thus the disfigurement of the fabric. We, in our own calico-print works, employ a process similar to this.

The next process was that of placing a pattern upon the cloth by simply stencilling the pattern

instead of printing it, the stencil-plates being formed of paper rendered non-absorbent by oil or some similar body, probably by Japanese lacquer. But of this process there are two methods, for in certain cases the pattern is stencilled in the ordinary manner, a dye being used as we use paint; in the other a "resist" is stencilled on the cloth, and the entire fabric is afterwards immersed in the dye-vat, when it becomes dyed in every part save that which was protected by the "resist." "Resist" may be starch or gum, or any material that will cover up the surface of the cloth and prevent a dye-stuff from coming in contact with it.

Another process consists in reversing the common operation of stencilling; thus in ordinary cases if we wished to stencil a leaf in red upon a white ground we should cut from a sheet of paper a leaf of the shape desired when we should have a hole in the paper from which we cut it of the same shape as the leaf cut out. In this case, we should use the sheet of paper from which the leaf had been cut, and by dabbing our red colour through this hole should get a copy of the leaf in red. But the method to which I now wish to draw your attention consists in using the leaf-like bit of paper which has been cut from the sheet, and placing it on the cloth, and spreading over it, and that portion of the cloth which surrounds it, by the agency of a sort of trowel, a paste-like "resist." This done, the leaf-shaped piece of paper is picked up from the fabric, together with that portion of the resist that covers it, by the agency of a point, or pin, and thus the fabric is left exposed where the paper leaf was. As many leaves as are desired are placed over the fabric, and the whole is covered with resist; the various leaves are now picked out and removed, and upon the resist becoming dry, the fabric is immersed in a dye, when the exposed parts—the leaves—acquire a colour, say red. This operation being completed, the resist is removed from the cloth by the action of water, and we have red leaves on a white ground.

Now I have to describe to you the process by which the more expensive fabrics receive figures, and I hope that I may make myself understood; but, as the process is difficult to describe, and as we, so far as I know, have no analogous process, I fear that I may fail in making the method of manufacture clear to you.

First, the fabric (always silk, I believe) is given to an artist, who draws the pattern upon it as carefully as if he were designing an historical cartoon. The pieces of fabric are about 40 ft. in length, and 12 in. in width, and on the entire piece the artist either places a varying or a repeating pattern, as may be desired. This pattern he draws with a preparation of indigo, which can readily be removed from the fabric by washing; and he not only gives outline, but also carefully adds depth, or shade, or whatever may enable him to produce a desired effect.

Thus, at the outset, the whole pattern is drawn by hand, and this we should think a sufficiently costly mode of producing a pattern; but, in the process which we are considering, the work is only now in its first stage of development.

The artist hands the fabric to a workman who has prepared for himself a material of the most tenacious and ductile character—a sort of glutinous bird-lime, This mucous matter he forms by boiling the finest possible rice flour with lime water of a particular strength. Having previously prepared his glutinous matter he warms it slightly and rubs it on a board with a sort of putty knife; but it appears to me as difficult to rub as warm india-rubber would be. A piece of this bird-lime about the size of a small pea is placed on the end of a wooden point, or skewer, and a portion of the fabric is stretched flat by bent pieces of cane; thus all is ready for work. Holding the frame over a small charcoal fire, and with one hand (the left) under the fabric, so as to raise any portion of it, and with the point of wood, on which is the little ball of plastic matter, in the other hand, the operator commences his work by touching the fabric at some point of the pattern, say at the base of a leaf, with the mucous ball, which at once adheres to the cloth. The ball of mucus is now drawn to some little distance from the surface of the fabric, say a foot, but between the fabric and the ball there now intervenes a thread of this mucus, for so ductile is the material, and so sticky that it will adhere to anything, and draw out to a thread some yards in length without breaking. By certain dexterous movements of the right hand, in which the wooden point by which the plastic matter is supported is held, and by the middle finger of the left hand raising the cloth when necessary, a thread is constantly being formed of the plastic matter, and is as constantly dropped upon the fabric as an outline to the pattern. With the utmost skill leaves, flowers, and even the small parts of the flowers, as the stamens, are outlined with this mucus, which falls upon the cloth as a thread of about the thickness of an ordinary pin-shank. The whole pattern, however small its detail, or however finely serrated its leaves, is outlined in this manner. But as this outline is not sufficient means are adopted for thickening it, hence a conical tube of oiled paper is formed of about four inches in length, and with an orifice at the broad end of about an inch. At the small end this tube terminates in a tin nozzle, in the apex of which is an opening such as would be made by a darning needle. This tube is charged with the mucus, and through the fine opening in the tin nozzle the plastic matter is pressed in such a manner as to thicken on the outside, and also to raise, the outline already formed. All this has afforded a means of preventing the "running" of dyes which are now to be used, and when thus prepared the fabric is ready for the next stage of the process.

This consists in the painting, with dyes of various colours, of the spaces enclosed by the little bank of the now dry, but formerly mucus, material, and a care is bestowed upon this painting, such as if a highly-finished water-colour drawing were being produced. In this way the pattern is wrought. The dyes having dried, the colours are exposed for about six minutes to the action of steam in a steam bath (which is a sort of kitchen "steamer," placed over a pot of boiling water), and then the mucus matter is removed by the fabric being gently rinsed in a vat of clean water.

If it is desired that the ground be coloured, the whole of the pattern is now painted over by a "resist," and the fabric is then dipped in the dye

vat, the ground receiving its colour, as it is unprotected.

Many fabrics are made by combinations of these processes, as I have already said. Thus, some are in part stencilled, and in part wrought by this last-mentioned method. To me it appears that the means of producing an effect which I have just described is the most laborious of any that I have known, but while it is a laborious means of achieving an end, the result gained is in the highest degree satisfactory, for what could be more delicious than parts of these fabrics?

Before we leave the consideration of the means by which fabrics receive their figure, or pattern, I will just say a word on the loom, as some of the Japanese brocades which receive their pattern by the loom are unsurpassed in beauty by any fabrics in the world.

I was taken to a factory which now receives a Government subsidy by the Mayor of Kioto, and here there were, perhaps, twenty looms weaving the richest of tissues. In some of the looms eight or ten shuttles were employed, each carrying gold, or some bright coloured silk. Now the Jacquard apparatus, if I may term it such, by which figure was given to the fabric, consisted of a youth of about seventeen summers, who, perched on a beam near the ceiling of the weaving-shed, gathered up the harness as necessary, and when all was collected, lifted it up and shouted to the weaver below to throw the shuttle across. This process of collecting the harness was gone through between every throw of the shuttle, and in this laborious manner the exquisite brocades of Japan are produced.

In the same shed with these primitive looms stood the newest Lyons loom with its perforated cards, and even the newest card-stamping machine, but the work produced by this latter was not comparable in beauty with that wrought by the more simple native contrivance.

I must now leave the consideration of fabrics, but to what shall we turn, for the manufactures of Japan are as varied as they are interesting.

Here is a fan, or screen, which I bought in the lovely old city of Nara; it, like most of the fans made in this district, is perforated, and it is not only perforated but is formed of silk; some of these fans, are, however, made of paper.

I observed the process by which these fans are made, and the perforation of the silk, or paper, is achieved simply by hand. Six thicknesses of the material are placed one above the other, whether it be paper or silk, and through the six thicknesses the perforations are at the one time cut by a knife; and however fine or intricate the pattern, and however large the order that has to be executed, six thickness only are cut at a time, and the cutting is entirely by hand.

Shall we now visit the metal-workers, and see how they conduct their manufactures, for what we shall here see is as remarkable as the means by which fabrics are figured.

This kettle is characteristic of what is in general use in Japan. I sincerely wish that it was characteristic of the kettles in general use in England. It is an object of pleasant form which is covered with conical protrusions having a geometrical arrangement. While the eminences by which the heating surface is so ingeniously increased are very numerous, and while they are so accurately disposed upon the surface that we can scarcely detect the slightest displacement of any one dot they are yet the result of hand labour. A hollow mould which is to give form to the outer surface of the kettle is made of sand, but it is yet smooth, and has been shaped on a block of wood of the required form. The mould-maker now takes a small bar of iron, about three inches in length, with an end so formed as to represent exactly one of the eminences which he wishes to have on the sides of the kettle. With this he makes depressions in the mould which has up to this time been smooth; and the positions of the depressions which he makes, and the degree of their depth (depressions which, when the pot is cast, will become eminences) he determines by eye, without the aid of any measurements whatever.

It is not uncommon to find Japanese bronzes, and even iron pots, with flowers, or birds, or a dragon in almost full relief upon them. The casting of such objects by us would be accomplished by "piece moulds," and casting by piece moulds is always expensive; but the Japanese will cast a chrysanthemum, with its numerous juxtaposed petals, as perfectly as a more simple ornament, and such a casting no piece-mould could enable us to produce.

Whatever is to be cast is modelled in wax: if a flower is to protrude in almost full relief from the sides of a pot, it is first modelled in wax. It is then attached to a wooden block of simple form, such as would, if the wax flower were not attached to it, drop from the sand were it used for the formation of a mould.

The model, consisting partly of wood and partly of wax being ready is carefully brushed over with a pulp formed of sandy clay. When this is dry, a second coating is given of a pulp containing more sand, and perhaps a third and a fourth. When these are dry sand is piled up around the mass and pressed into the interstices between the parts, but these are already largely filled by the previous applications of semi-fluid matter. When sufficient sand has been pressed around the model to form a solid mould the mass is taken to a sort of kiln or muffle and is there exposed to a degree of heat sufficient to melt out all the wax, which first becomes absorbed by the sand, and then dissipated as gas from the mould. The wax of which I am speaking is not wax simply, but a mixture of wax and resin. The mould is now prepared, but I did not see the actual casting. One of the largest bronze manufacturers in Tokio kindly offered to give up a day in order to show me the entire process, but I was, unforunately, so occupied, that I could not avail myself of his kindness. I was, however, told that the moulds were warmed before the casting was made so that the metal might not be chilled while running along the smaller channels of the mould, and this, I think, very likely, but as all my information had to be gathered through interpreters great difficulties were experienced, for in some instances excellent interpreters do not happen to know the technical terms which belong to special trades and manufactures. For the interesting castings now before us I am indebted to Messrs. Jackson and Graham.

If a thousand vases had to be cast, each with a flower in relief on the side, and if each vase was

to be of precisely the same pattern, a separate model would yet be prepared for the casting of each, and the same labour would be expended in producing every one that was expended on the production of the first.

I have spoken of the difficulty of gathering information through an interpreter: with the view of illustrating this statement I will give you one example. When viewing the enormous bronze figure of Daibutz (Buddha) at Kamakura, together with Mr. Mountsey, who had kindly taken the chief native interpreter from the embassy at Tokio with him in order that I got the fullest possible information respecting what we might see, I observed two large metal loops jutting out from the back of the figure near the scapulæ or shoulder blades, and asked what purpose these served, as I could see no use for them. The immediate reply was "for the shine, for the shine;" I confess that I was puzzled, and after making many guesses at his meaning gave up all attempts at discovering the purport of his remarks.

By the road-side, as we journeyed homewards, was a celebrated Buddhist temple which we stopped to see, and in it were many images with nimbi. No sooner had our interpreter caught sight of a nimbus than he exclaimed "the shine, the shine," when we at once discovered the use of the loops on the back of the great Daibutz, which were fixings for the nimbus, and wondered at our own ignorance, for have we not the word "shining," which is akin to "glory."

While speaking of interpreters, I would take the opportunity of mentioning the fact that the gentleman, Mr. Sakata, or, as they would say Sakata San, who was appointed by the Government as one of my escort through Japan, and who acted as my interpreter during my long journey in the interior, scarcely ever failed rightly to render even technical terms. Without doubt he was the most skilled interpreter that I ever met with, and he was also a most charming gentleman and companion.

I had hoped to have told you how that wonderful process of enamelling on earthenware is managed, for while we know how to make cloisonné enamel work on metal (Messrs. Cristoffle, of Paris, having sent a man to China to acquire the art and we getting it from him), the manufacture of cloisonné on earthenware is an art peculiar to Japan. I have, however, seen the whole process and through the kindness of Dr. Raretz, of Nagoya, am possessed of illustrations of the manufacture in every stage of development, and I have also got samples of every material used in the manufacture, but as I have not yet been able to analyse the various substances I cannot give you the information which I had hoped to have given you on this occasion, but at this I feel less regret than I otherwise should for I fear I am almost pledged to write a large work on Japanese processes of manufacture.

Perhaps the most characteristic and the most beautiful art of Japan is the lacquer manufacture, for what can be more lovely than some of the specimens I am, through the kindness of Messrs. Jackson and Graham, enabled now to show you? Some of these are very old, and all have merits, while for delicacy of treatment, attention to detail, and exquisite finish, some are unequalled by any works, so far as I know, that any other people have produced. Lacquer is, with the Japanese, an old art. In my judgment its best period was from 600 to 400 years back, and I had every opportunity of judging for in the Mikado's private collection of antiquities in Kioto—not the collection at Nara of which I before spoke—are many examples with authentic dates. As a manufacture it reached its highest development from about 300 years to 100 years since, but while the workmanship achieved the highest excellence at this period the drawing of the decorations is not so pure and good as at the earlier date; and I was informed by the keeper of the royal collections at Kioto that formerly the patterns were drawn upon the objects by artists and not by lacquer-workers, whereas, during the later period, the lacquer-workers were also the artists.

This old lacquer has now great value. For a box about six inches square I was asked in Japan £100 sterling, and Lady Parks told me that fine specimens were, in Tokio, bringing their weight in gold. Messrs. Jackson and Graham have the good fortune to possess the only considerable collection of old lacquer that is for sale in Europe, and fortunate they indeed are in their possession, for old lacquer is rising in price rapidly and is now almost unknown in Japan. The taste for lacquer work is also setting in amongst us, and surely no objects are more worthy of admiration than the beautiful works in lacquer which during the last 600 years Japan has produced.

I have here a piece of lacquer which has rarely been equalled, and perhaps never excelled, in its own way. The Japanese are great admirers of cherry blossoms; indeed, they like all flowers that they have to look up to, but the cherry blossom is a special favourite. Here we have the cherry-tree with a profusion of blossoms mingled with young leaves; but it is not to the poetical thought associated in the Japanese mind with the cherry-tree that I would call your attention, nor to the pleasant reminiscences of picnics which have taken place on the cherry-clad hills during the season of the flowers—reminiscences common to all Japanese —but to the simple excellence of the work, whether it be regarded as a mere piece of manufacture or as a work of art.

Nothing could be more perfect than this work is. In drawing it is excellent, in delicacy of treatment most tender, in consistency all that could be desired. Our merchant princes give £1,000 for a painting, or even £5,000, and yet they have up to the present time hesitated to give £200 or £300 for a work so noble and so pure as this. Believe me the time is not far distant when, through better art education, the superior merits of these lovely works will be so fully appreciated that the keenest competition for their possession will take place; indeed, this competition has already set in. And this is certain, that the world can never see many works so lovely as this and others that Messrs. Jackson and Graham have so kindly placed around me, and many are of nearly the same excellence.

I am glad to be able to tell you that at the present moment lacquer wares can be made having the best qualities that lacquer wares ever possessed; but if good, they must be very expensive, even more so than the present prices of the old pieces, for the

method of production is most laborious, and the cost of labour has of late years so greatly increased in Japan, that the sum of money that will now buy a poor man one pair of sandals, would ten years since have bought him twenty-seven pairs.

Under the auspices of the Japanese Government a company has been established with the view of redeeming the arts from the corrupting influences of the large European and American demand, and in this company the Hon. Mr. Sano—to whom I am indebted for so many acts of kindness, and for much information, as I before told you—takes a warm interest. This company may do much to maintain the excellence of Japanese manufactures and I wish it well, but its management must be conducted with care as I fear that even the Japanese ministers have but an imperfect idea of the enormous demand which Europe makes upon Japan for excellent works. If, however, Japan can produce works of the highest quality in sufficient quantities, Europe certainly can furnish the market for their sale, for we know the excellence of their works and love them.

As to the process of lacquer manufacture. First, a wooden object is prepared, for nearly all lacquer is worked on wood and not on papier-maché as some suppose. If common objects are to be formed small pieces of paper are stuck over any little defects which the wood may present. Then the whole is coated with lacquer. This coating being dry, little roughnesses are rubbed off with a lump of coarse charcoal, and another coat is added, which in its turn is rubbed smooth. Four or five repetitions of this process complete the object unless it is to be decorated.

If a gold spray is desired on a common vessel it is first drawn in a lacquer, the lacquer being used as a gold size, and when the lacquer is in part dry, gold bronze (powder) is sprinkled upon the drawing, which gold bronze adheres to the wet size.

What I have said only describes the process of making common lacquer objects, and before I proceed to show how the finer work is produced let me say that lacquer is a thick fluid which often resembles in appearance pale treacle, or what is called golden syrup. I think that it must flow from the vessels of the tree which produces it for it is more nearly allied to gutta-percha than to a gum resin. It is unhurt by hot water or ordinary acids, resisting alike the action of strong vinegar and boiling water. I find that it will resist the action of boiling acetic acid, and of the strongest caustic potash, hence no ingredients used in cookery could hurt it. It is, when in its fluid state, highly corrosive, for if one solitary drop comes in contact with the skin it produces a wound which generally eats itself through to the bone; even from visiting a lacquer factory some persons take a kind of fever. How it dries, or whether it dries or not, in ordinary air I did not learn, for it is always dried in the factory in a cupboard the interior of which is brushed all over with water every day so as to produce an atmosphere saturated with moisture; in this damp air it dries in from eight to eleven hours.

A good piece of plain (undecorated) lacquer work has already received about eleven coatings of lacquer, and has been carefully ground down after receiving each separate coating. This object being now prepared for decoration a pattern is transferred to it by an outline being made on a piece of paper in lacquer which has been warmed or boiled (this heating having the effect of retarding or preventing its drying). The pattern being thus drawn the paper bearing it is placed face downwards on the object to be decorated and rubbed at the back when a transfer of the outline to the lacquer surface has been effected just as we copy a letter, or as an engraver takes a proof impression from a wooden "block." The paper is now peeled off and can be used again if it is desired to repeat the pattern, for several transfers can be made from the one drawing.

This done, if the ornament is to have a gold outline, the lines of the transfer are followed by a fine brush containing lacquer which acts as a gold-size, and I noticed that the lacquer used for these outlines dried so rapidly that no sooner was a leaf outlined than the gold powder was dusted upon it. I also observed that the gold used for this best work had the appearance, when shaken upon the work, of a grey powder, and looked rather like an oxide than a pure metal, but when, after adhering to the lacquer, it was rubbed, it at once became bright and gold-like.

The variety of surfaces that the lacquer worker achieves appears to be endless. If a solid gold surface is desired, it is produced by a fine gold powder being sprinkled upon, and somewhat rubbed into, a surface which has been covered with wet lacquer. If clouded gold is required it is formed by gold dust being shaken through a reed which is about four inches in length and the end of which is covered with fine silk. If a coloured ornament is required with a clouded gold surface the ornament is first painted in the required colour or colours and upon this colour the gold dust is sprinkled. By this means some of the richest effects of lacquer are produced.

On many fine pieces of lacquer we find little squares of gold; these are about the thickness of ordinary writing paper, and are cut from a sheet of gold by a sort of knife. When a quantity has been cut they are placed upon a little tray which is held upon the thumb in the manner that a gilder's pad is held and from this the little tesseræ are taken one at a time by a pointed skewer of wood which is pressed upon them—the mere pressure causing them to adhere to it—and are placed on the lacquered surface. Over the gold work, however the gold has been applied, if the lacquer ware is anything better than common from one to several coatings of lacquer are placed according to its excellence; the first is ground off every projection, however small, and remains only between the grains of metal, the rubbing down being most carefully effected by a woman who employs for that purpose a small piece of charcoal. A coating of transparent lacquer is now given, which, in its turn is ground down, and then another, till finally the work is polished by the agency of the ash of deer's horn applied with soft leather.

Raised work results from the application, first in a rough form, of lacquer mixed with bone-dust; this is, in all cases, applied by a brush, and is never the result of cutting or carving. When this heaped-up lacquer begins to assume the desired shape, owing to repeated applications, its form is carefully

modified by grinding with small lumps, or strips, of charcoal, and for this purpose charcoal of about 20 degrees of hardness is employed. By repeated painting and grinding form is given to the raised parts which are often truly works in *alto relievo*, and when brought to their shape they are coloured, painted, or dusted with gold, as the case may require.

I could say more on lacquer work; and I have mentioned only few of the manufactures of Japan, but I have exhausted my time and your patience, I fear; yet I cannot close without making one remark, which is this, that while the art processes of Japan are such as render the production of quantity impossible, if excellence is to be attained, they yet secure the highest degree of art merit. I have watched the poor artisan labouring at his work with an earnestness and love such as I never beheld out of Japan, and the very features of the workmen testify to their happiness, and to the love with which they perform their pains-taking labour. No thought of gain appears to enter their minds, and no touch is spared which will make the work more lovely; this is how the beautiful works which we delight to look upon are produced. They are works born of loving labour; they are the children of happy contented men who love their labour as they love their lives, and who, separated from the former, would part with the latter. How different are these from our workmen. The one supremely happy, the other always unhappy, for he who seeks to do the least work possible for the largest amount of gain can never know peace; the one perfectly contented with the simplest of fare, the other always craving after more while yet well fed. If our workmen could but see the dear old men of Japan engaged in their various handicrafts they could not fail to learn that happiness is not found in short hours and high pay, but in the love of our work. And this is the reward which these poor men receive—perfect happiness! The Japanese handicraftsman, owing to his happiness, content, and skill, have the friendship and patronage of the lords of the land (the Daimios), who will converse with them and receive them at their palaces, whilst no merely moneyed man—even the richest of merchants—has any status in Japanese society; but we must ever remember that through his virtues the workman has made himself worthy of the friendship of his lord, and a fitting companion for him.

In a little over three months I had to conclude my wanderings in this most interesting country, and to close the note-book in which I had recorded so many interesting processes. I had made my collection of typical wares, some of which went to Messrs. Tiffany of New York, who, I believe, after they had gathered the information that they desired, with the authority that they kindly considered my researches gave them, sold what they did not care to retain under the auction hammer; the other part is now doing its tutorial work, and as it is finished with will come into the possession of our museums or great houses. Part has already gone to Glasgow, but the destiny of the major part of the collection has not, I believe, yet been considered. Now the ministers entertained me at a banquet in the summer palace of the Empress and with their best wishes I left Japan for China.

In making a tutorial collection of both old and new things, and in preparing a report on the manufactures of Japan, I fulfilled my duty to Messrs. Londos and Co., whom I would now thank for the kindness and liberality which I received at their hands; and in making known to my fellow-countrymen the art processes by which the Japanese achieve their beautiful results, and the contented happiness of their workmen, I am performing the duty which I owe to the nation. I know how little I have been able to say to-night, but my book, when written, must supply the fuller information which I should have liked to have given in this paper. I would now thank Messrs. Jackson and Graham for their kindness in stripping their show-rooms of valuable articles in order that my paper this evening receive illustration, and I am sure that they will at all times have pleasure in letting those who are interested in the work which the great art-workmen of Japan produce, walk through their beautiful galleries, and in them will be found a collection of Japanese objects which is, I believe, unrivalled in Europe. And to you, Sir Rutherford, I would return my sincere thanks, not only for your kindness by honouring me by your presence here to-night as my chairman, but also for your goodness to me in times past. No man has done more in forming my art character than you have done, for you first taught me to love and understand Japanese art, and I am the gainer by that love. I, thus, publicly, return you my hearty thanks for all your acts of kindness to me.

DISCUSSION.

The Chairman, in proposing a vote of thanks to Dr. Dresser for his very interesting paper, said he would be glad to hear any observations from any of the gentlemen present, connected with either of the processes which had been alluded to, or any questions which might be put that would elicit further information.

Mr. F. Aumonier said it would add greatly to the value and interest of the paper if Dr. Dresser could add any remarks on the paper manufacture of Japan.

Mr. H. W. Freeland thought that if Dr. Dresser could, at the same time, give any information in regard to the wages received by Japanese workmen, it would be interesting. The lesson of contentment he had taught to the English workmen they would all appreciate, but if he could give any information with regard to the wages received by skilled workmen there, from which that state of contentment sprung, and if he could further give any general idea as to the cost of living, which had to be provided out of those wages, it would add largely to the benefits which he had conferred upon his hearers.

Mr. Liggins thought that this was perhaps the most interesting meeting of the Society they had had for a long time. It brought before them the interesting fact that they could obtain from distant parts of the world many interesting products. Only the other day he saw in the public journals that one of the Cunard steamers was being fitted up with wood-work made in Japan; and he should like to ask the lecturer whether he could give any information with regard to the specimens of woodwork exhibited. Were they made by any particular process, or with different tools to those which would be employed on similar work in this country?

Mr. Cornelius Pare thought it would be well if Dr. Dresser would explain how it was, in the face of the re-

mark he had made that most of these things were made by a man and a boy, that large quantities of articles were imported from Japan. For instance, in the lacquer trays, some 200,000 had been imported; of cabinets, perhaps, 25,000; boxes, 150,000; fans, an almost unlimited number; fishing rods, something like 60,000, and of umbrellas, 200,000. He would like to know how it was that a few workers could produce that quantity. With regard to the remark that the beautiful art work produced years ago in Japan could be reproduced, that a company was started to be assisted by Government funds, he would only say that he had seen some productions of modern artists in Japan, attempts to copy the old productions, and he should advise those who had any old pieces, or could obtain them, to retain them for some time to come, for he fancied their value would increase. He doubted, in fact, whether similar articles could be produced. He had seen nothing like them of late years. These beautiful objects were, no doubt, produced for the love of the work itself. But he did not believe in the Japanese being more virtuous than anyone else, or that they ever were able to disregard the amount of money they could earn. If they could make a million articles, and earn £1,000, they would not sit down to make one in order to get £100. He was sorry Dr. Dresser had not had time to describe more in detail the articles he had shown, and he hoped he would be able to supplement this lecture by another at some future time.

Mr. Beck asked if the splendid large vases, some of which had been sent over lately were made by the simple process described, a man sitting and spinning a potters' wheel with his fingers. He should imagine it would be rather hard work to produce a vase of 4 ft. 6 in. in that manner.

Mr George Wallis said that, to the student of technical processes, it was very curious to note how singularly the Japanese appeared to have fallen on the well-known European methods in certain processes; as, for instance, the old "draw boy" of the Spitalfields weaver. The great point of interest to him, however, was, what was the main lesson to be learned from this paper with regard to our own methods of manufacture and design. In the Japanese workman there was first an intense love of nature; he was a student of nature, and loved birds, flowers, and insects, and he carried out this love in his work. But the great point was that he thought, so to speak, through the material in which he worked. In all his experience and examination of Japanese objects he had failed to find any evidence that the workmen had ever thought of imitating any other material, method, or process than that in which and for which he was working. Now the great mistake, not only in English but in almost all European design, was that what was good in one manufacture or material was imitated in some other material, for some other purpose and in some other method; and thus failure was inevitable from the very beginning. Just by way of illustration, they all knew how Pugin and other early writers on art education had abused English cast-iron work; but the cause of the abominable stuff which had been produced until lately—for it was now improving—was that the designer or workman thought through a stone or wooden idea, and the result was you got the cast iron in the shape in which it ought to appear in wood and stone, a totally different material. This principle might be applied over and over again. The Spitalfields weaver of old times was a lover of nature, and he kept birds and flowers, and this love of nature, brought over by the Huguenots from France, still lingered in Bethnal-green, though the silk trade was dead. Actuated by these feelings, they produced very beautiful patterns in silk, which the calico printers then proceeded to copy after a fashion, and the result was an absolute failure, whereas when the calico printer adhered to the earlier processes by which calicoes were printed, he did his work as truly as the Japanese. This was the true secret of success in all art-workmanship of any kind, and many other illustrations could be given of it if time permitted. So long as a man was master of his tools, he would do good work; but when he went on a wrong system his tools or machinery mastered him, and the result was failure.

The vote of thanks having been passed,

Dr. Dresser, in reply, said it was too late to make any remarks on the paper manufacture, which he must defer to another opportunity. With respect to the wages question he had found it very difficult to get any information, though he had been especially requested to inquire into it by Mr. Mounsey, the first secretary of the legation. A man made a piece of work and sold it for a certain sum, but as he might spend a week over one and five weeks over another, according as he felt inspired, it was very difficult to ascertain his average earnings. He could only say this, that Messrs. Londos had ordered a service of silver, consisting of tea-pot, sugar-basin, and milk-jug, which was to be made by the very best workmen, and their collective labour amounted to 1,600 days, yet the retail price in London was only £300. That was the only data he could give on the subject. It was quite true that one of the Cunard steamers was to be fitted with woodwork from Japan; and, more curious still, it was found to pay to import bricks from Japan to England. The Japanese possessed no mechanical advantage over us, rather the reverse, but there could be no doubt that labour was much cheaper. He was rather surprised at Mr. Pare's remarks, seeing that that gentleman was a member of the firm of Londos and Co., to whom he was art adviser. With regard to the quantities, it did not matter whether you had a machine which made thousands of articles, or thousands of individuals who made one each. He had seen a large village—almost a town—entirely engaged in manufacturing umbrellas, and the entire country round was dotted with them, put out to dry, like mushrooms. Sometimes, again, you saw little forests of dolls' heads. All these things were made in cottages; not in factories. They were all, however, common things. What he said was, that Japan could not produce quantities if excellence was to be achieved. Mr. Pare also doubted whether Japan could produce work as good as formerly, but he was quite sure it could, though not in large quantities. Mr. Pare had not yet seen them, but it was only eight months since he left Japan, and it would be a year or two before the first piece would arrive. In 20 or 30 years there might be several. He perfectly concurred in the remarks of Mr. Wallis, who had had great experience in these matters, for it was quite true that the Japanese workman did think through the material which he employed.

MISCELLANEOUS.

DOMESTIC ECONOMY, HEALTH, AND MUSIC AT KEIGHLEY.

The Trade and Art Schools of Keighley held their annual meeting on the 17th January, when Sir Henry Cole, K.C.B., distributed the prizes and made some observations on subjects which the Society is now promoting. He alluded to Adam Smith, who, about 100 years ago, said he saw nothing more useful to industry than the teaching of practical geometry by Government, and the giving of prizes to the successful students. He told them that when he (Sir Henry) first began the work of Schools of Science and Art he had great difficulties to contend with, and when he proposed that geometry

should be taught, he received a memorandum from an eminent political economist, who said that he saw no reason why geometry should be taught to carpenters and masons. He, however, took the memorandum to his superior, the veteran member of the House of Commons, Mr. Henley, who said that he saw every reason, and told him to go on with the work. Sir Henry thought that many of the sciences—physics, chemistry, and above all physiology, were of great influence upon matters that were even of more importance than trade, and that was upon Health. He thought that if men were miserable wretches without health, they could not be good workmen, and therefore the first thing they had to do, was to exert their utmost to be as healthy as possible. Under their present system of elementary education children were taught little knowledge bearing on their lives, the water they drank, the air they breathed, &c. Those should all be made the subjects of interest and importance, and yet of these they learnt no fact and people were surprised at the consequences of this ignorance. He did not blame the managers of schools for not having taught them. He supposed that most of them read the newspapers, and had heard of Domestic Economy. All the life that they passed at home was regulated by the laws of science. The present Government about three years ago introduced the term Domestic Economy into the Educational Code, and in that Code Domestic Economy was defined as Food and its preparation, Health, Thrift, &c. Every child who passed the fourth standard and passed in Domestic Economy, earned 4s. for the school committee. The Government, however, had taken no effective means of creating an interest in the subject, and the consequence was that it had fallen to be nearly a dead letter. Some thirty children, out of nearly two millions, certified as passing in cookery! He thought it would be a good thing for the managers of that school to look into Domestic Economy, and he could put them in the way of getting help. Most of them would have heard of the Society of Arts. He would recommend them to join the Society of Arts, and the members of the Institute would be able to get prizes for Domestic Economy, and in many other subjects. Domestic Economy sounded a fine name, but after all it only meant the science of how they should live and how they should live well, and he could not conceive any set of subjects more attractive. Last year he attended a conference at Birmingham on the subject, and some of the most eloquent speeches which he heard were made by women, for Domestic Economy was woman's work. There was another subject in which, he was sorry to say, this part of the country, and the northern counties especially, were sadly deficient, and that was the Public Health question—Sanitation, they called it. He then quoted a number of figures on this subject, showing the waste which was continually going on among the towns of Yorkshire and Lancashire, of fertilising materials. Especially referring to the state of the town, he said that Keighley was in a very fair condition; but, as regards Leeds, it was in a very bad condition, and they ought to offer up prayers for its reformation. Bradford was just one shade better; it did not pollute its river as much. There were also several other towns which he mentioned which were bad; they at Keighley were a great deal better, but far from right. There was an estimable little book, called the "Keighley Year Book," and from that book he had endeavoured to obtain some facts. He had endeavoured to estimate, from figures in this book, what each individual who lived in Keighley contributed for the general public Health every week. If he were to ask of each of them a shilling a week to keep them in good health, and to prevent them having to run up such large doctors' bills, they would not think it an extravagant price; but instead of a shilling a week, he made out that they were taxed only about ½d. each per week. He thought that they ought to make up their minds to give a little more than a ½d. per week to keep them well. There was another question in which he ventured to think there was a little to be done in Keighley. It was revealed to him that day, that during the past week they had been having country dances in that hall, and he thought that it was an exceedingly good thing to have dancing, under good regulation, and without intoxicating drinks, and for his part he should say that if the lads and lassies had a weekly country dance it would turn the hall to good account. There was the subject of Music. They had a school of art, but if it was a real school of all fine art, it would include Music. Music was an art and a science, and if they came to reflect upon it it was the one art which would be of the greatest use. They could do without drawings and pictures, but not a bit could they do without music. It was almost the first thing that a baby cared about was to be sung to sleep; they could not fight a battle without the trumpet, and there was not a place of worship which could do without music more or less. He did not think that they attended to Music sufficiently in Keighley. They had their occasional concerts, and they had their music in church in a half-hearted sort of way, but he did venture to say that they ought to have Music as a science and art, and it ought to be systematically taught. He would advise them that in the Institute they should establish classes of Music and have it taught, and that they should also encourage and go round to the elementary schools to see that the children were taught a little more than "Home, sweet home." He thought that if the committee tried they might be able to squeeze out a sum of £60 a year, and then they might do what other towns had done; they might send the untrained genius up to the National Training School to be trained for his own benefit and the benefit of his country. There was also the subject of a Museum. He had told a friend of his that day an easy process by which they could get the beginning of a Museum. They would see in the art rooms a number of cases of dishes made in metal, and they would also see a number of casts. If they would systematically try they could easily get a Museum, and for every £100 worth of articles which they purchased from the South Kensington authorities, they would let them have them and pay £75, so that it would cost them only £25. They could set about the work and they might have copies of the best pictures (because they could never get the originals) and casts, and he believed they could instruct the young and delight a great many others whom they would not be able to instruct by any other method. He thought they might begin the thing, but it would not be carried out to any great extent until their municipal organisations became a real Corporation. He thought they were already on the road to it, as they had trained a number of men to be their aldermen. His own opinion was that if they could agree upon some paltry details of boundaries they would have no trouble in getting a Corporation, and there was no doubt that they could get a great many things which their Board of Health could not get, and he would recommend them to get a Corporation at Keighley as soon as possible.

EDINBURGH SCHOOL OF COOKERY.

The second annual meeting of the Edinburgh School of Cookery was held on the 23rd inst.

Miss Guthrie Wright, the hon. secretary, read the report, which stated that during the session of 1876-77 demonstration and practice lessons in high-class, plain, and cheap cookery were given in the temporary premises at the School of Arts. Courses of public lessons on cheap cookery were given in various districts of Edinburgh, in Leith, and in Portobello, and classes were held in seven institutions and schools. During the year branch classes were, on application, conducted in 41 different towns and villages. The committee were glad to report that, with one or

two exceptions, the attendance in all these places was large, and that the evening classes for cheap cookery were especially successful. In three towns the evening attendance reached nearly 1,000, and in many towns it was not unusual to see a class of from 500 to 700 persons. In one town the proceeds of 24 lessons on cheap cookery amounted to £130 12s. 10d., taken in sums of 3d. and 2d. That success was largely due to the energy of the local committees, and also to the hearty co-operation of the teachers of the school. As the result of these branch classes, local committees had reported not only great general improvement in the cookery and economy of the district, but many individual instances of increased comfort in the homes of the working classes. Applications for classes from numerous towns and villages throughout the country continued to be received, and would be supplied as rapidly as the resources of the school would permit. At the close of the financial year, on October 9th, 1877, the proceeds of town and country classes amounted to £3,481 19s. 4d. The balance on hand of £1,883 1s. 1d. included part of the sum which the committee were authorised to raise by contribution, for the purpose of leasing and fitting up permanent premises, and otherwise organising the school. The committee have been successful in securing suitable premises in the Albert-buildings, Shandwick-place, which they have fitted up with every convenience for efficiently conducting their classes. They have made provision for one teacher residing on the premises. The committee were of opinion that the teaching of cookery and domestic management should be made an essential component part of the education of girls of all classes, and that it should be introduced into the schools in which the other ordinary branches are taught. They also advised that universities and hospitals should make provision for the teaching of sick-room cookery to medical students; and, further, they anticipated that, as the school progressed, they would, at a future date, be in a position to give special lessons in the preparation of food to soldiers, sailors, and intending colonists.

Miss Louisa Stevenson, the hon. treasurer, submitted an abstract of the receipts and expenditure of the Edinburgh School of Cookery for the year ending 9th October last, from which it appeared that there was a balance at the beginning of the year of £689 2s. 11d., and that the receipts during the year from various sources amounted to £3,711 3s. 5d., making a total of £4,400 6s. 4d. The expenditure for the year was £2,517 5s. 3d. and there was thus a balance left at 9th October last of £1,883 1s. 1d.

THE PRACTICAL USES OF ELECTRICITY.

Dr. Siemens, in his presidential address to the Society of Telegraph Engineers, on Wednesday, the 23rd inst., made the following remarks on recent practical applications of electricity other than telegraphic:—

Electricity has hitherto rendered service as the swift agency by which our thoughts are flashed to great distances, but it is gradually asserting its rights also as a means of accomplishing results where the exertion of quantitative effects are required. Much has been said about the application of electricity for producing light, and the French Alliance Company, as well as the Gramme Company, have, it is known, for some years been establishing magneto-electric apparatus to illuminate the lighthouses upon the French coast and for galvano-plastic purposes. By an ingenious combination of two magneto-electric machines, with Siemens armatures, Mr. Wilde, of Manchester, succeeded in greatly augmenting the effects produced by purely mechanical means; but the greatest impulse in this direction was given in 1866-67 by the introduction of the dynamo-electrical principle, which enables us to accumulate the current active in the electric circuit to the utmost extent permissible by the conductive capacity of the wire employed. Dr. Tyndall and Mr. Douglass, chief engineer to the Trinity Board, in reporting lately to the Elder Brethren upon the power of these machines and their applicability to lighthouses, give a table showing that a machine weighing not more than 3 cwt. is capable of producing a light equal to 1,250-candle power per horse power expenditure of mechanical energy. Assuming that each horse-power is maintained with an expenditure of 3 lb. of coal per hour (which is an excessive estimate), it would appear that 1 lb. of coal suffices to maintain a light equal to 417½ normal candles for one hour. The same amount of light would be produced by 139 cubic feet of gas of 18-candle power, for the production of which 30 lb. of coals is consumed. Assuming that of this quantity, after heating the retorts, &c., 50 per cent. is returned in the form of gas-coke, there remains a net expenditure of 15 lb. of coal in the case of gas-lighting to produce the effect of 1 lb. of fuel expended in electric lighting, or a ratio of 15 to 1 in favour of the latter. Add to the advantages of cheapness in maintenance, and of a reduced capital expenditure in favour of the electric light, those of its great superiority in quality and its freedom from the deleterious effects of gas in heating and polluting the atmosphere in which it burns, and it seems not improbable that it will supersede before long its competitor in may of its applications. For lighthouses, for military purposes, and for the illumination of large works and public buildings the electric light has already made steady progress, while for domestic applications the electric candle proposed by Jablikoff, or modifications of the same, are likely to solve the difficulty of moderating and distributing the intense light produced by the ordinary electric lamp. The complete realisation of all the advantages of the electric light remains, however, a problem to be solved, and it would be extravagant to expect from applications on a small scale, such as have hitherto been made, anything like the amount of relative advantage indicated by theory. The dynamo-electric machine has also been applied with considerable success to metallurgical processes, such as the precipitation of copper in what is termed the wet process of smelting. The effect of one horse-power expended in driving a dynamo-electric machine of suitable construction is to precipitate 21 lb. of copper per 24 hours, equivalent to an expenditure of 72 lb. of coal, taking a consumption of 3 lb. of coal per horse-power per hour. Electrolytic action for the separation of metals need not be confined, however, to aqueous solutions, but will take, perhaps, an equally important development for the separation in a state of fusion of the lighter metals, such as aluminium, calcium, and of some of the rarer metals, such as potassium, sodium, &c., from their compounds. Enough has been shown by Professor Himly, of Kiel, and others, to prove what can be done in this direction, although there remain practical difficulties (chiefly the rapid destruction of the vessels containing the fused masses), the removal of which will require patient perseverance, but they are not likely to prove of an insuperable character. In an inaugural address which I had occasion to deliver to the Iron and Steel Institute a twelvemonth ago, I called attention to another application of the dynamo-electric current, that of conveying mechanical power, especially the power of such natural sources as waterfalls, to distant places, where such power may find useful application. Experiments have since been made with a view to ascertain the per-centage of power that may thus be ulilised at a distance, and the results of these experiments are decidedly favourable for such an application of the electrical conductor. A small machine, weighing 3 cwt. and entirely self-contained, was found to exert 2·3 horse-power as measured by a Prony's brake, with an expenditure of five-horse power at the other end of the electric conductor, thus proving that about 40 per cent. of the power expended at the distant place may be recovered; the 60 per cent. lost in transmission includes the friction of both the dynamo-electric and electro-

motive engines, the resistance of the conductor, and the loss of power sustained in effecting the double conversion. This amount of loss seems considerable, and would be still greater, if the conductor through which the power were transmitted were of great length and relatively greater resistance; but, on the other hand, it must be remembered that the power of a natural motor is obtained without expenditure of coal, and that a small caloric motor, which the electric motor is intended to supplant, is inconvenient and very extravagant in fuel. The electric motor presents, moreover, this great advantage, that it requires hardly any installation, and would be available at any time by merely closing the electric circuit without incurring the risk and inconvenience inseparable from steam and gas engines. Without considering at present the utilisation of natural forces, let us take the case of simply distributing the power of a steam-engine of say 100 horse-power to 20 stations within a circle of a mile diameter, for the production of both light and power. The power of 100 horses can be produced with an expenditure of 250 lb. of coal per hour, if the engine is constructed upon economical principles, or of $250\text{-}20 = 1{\cdot}25$ lb. per station. In the case of the current being utilised for the production of light $2{\cdot}3 + 1{,}200 = 2{,}760$, or say, 2,000-candle power, are producible at the station, whereas, if power is desired, 2·3 horse-power may be obtained, in both cases with the expenditure of 12·5 lb. of coal, representing 1d. per hour for cost of fuel, taken at 15s. a ton. The size of the conductor necessary to convey the effect produced at each station need not exceed half-an-inch in external diameter, and its cost of establishment and maintenance would be small as compared with that of gas or water-pipes for the conveyance of the same amount of power. Electricity, which in the days of Franklin, Galvani, Volta, and Le Sage was regarded as an ingenious plaything for speculative minds, and did not advance materially from that position in the time of Oersted and Ampère, of Gauss and Weber, and not indeed until the noonday of our immortal Faraday, has, in our own times, grown to be the swift messenger by which our thoughts can be flashed either overland or through the depths of the sea to smaller or greater distances, circumscribed only by terrestrial limits. It is known to be capable of transmitting, not only language expressed in conventional cipher, but facsimile copies of our drawings and handwriting, and at the present day even the sounds of our voices, and of resuscitating the same from mechanical records long after the speaker has passed away. In the arts it plays already an important part throughout the creation by Jacobi of the galvano-plastic process, and in further extension of the same principle it is rapidly becoming an important agent in the carrying out of metallurgical processes upon a large scale. It has now appeared as the formidable rival of gas and oil for the production of light, and, unlike those inferior agents, it asserts its higher nature in rivalling solar light for the production of photographic images; and finally it enters the ranks as a rival of the steam-engine for the transmission and utilisation of mechanical power. Who could doubt, under these circumstances, that there remains an ample field for the exercise of the ingenuity and enterprise of the members of that society I have just had the honour of addressing?

NEW SOUTH WALES.*

The eastern part of Australia was discovered by Captain Cook in 1770, during his first voyage in the ship *Endeavour*. The bold and broken character of the coast reminded him of South Wales, and hence he gave the name of New South Wales to the newly-discovered country.

* A sketch of New South Wales, 1788 to 1876. Extracts from a Paper read by Sir Daniel Cooper, Bart., at the Royal Colonial Institute, Jan. 22, 1878.

On the 26th January, 1788, the first Governor, Captain Arthur Philip, R.N., landed at the head of Sydney Cove, Port Jackson, with the earliest settlers, and proclaimed the limits of the new colony. At various times these limits have been reduced.

In 1803, Tasmania was put under a separate Government, and South Australia in 1836. Victoria, after a few years guidance under a superintendent, was finally separated in 1851, and, lastly, Queensland in 1859. The colony thus curtailed, still comprises an area of 207,000,000 acres.

At the first numbering of the people, there were found to be 1,030 men, women, and children; and their wealth consisted of 5 head of cattle, 6 horses, 20 goats, 29 sheep, 74 pigs, with 18 turkeys, and some geese and fowls. At the end of 1793, the quantity of land transferred to settlers was 3,470 acres.

At the close of the year 1794 wheat was 10s. per bushel; maize, 7s.; the value of a Cape ewe, £6 to £8 8s.; a she goat, £8 8s.; a full-grown hog, £3 10s.; an English cow, £80. Jamaica rum, £1 to £1 8s. per gallon; Madeira wine, 12s. per gallon.

The colonists suffered great hardships at times from want of food, vicissitudes of weather, and the difficulties of managing the class of people sent out as the first colonists, and also from the hostility of the aborigines. Governor Philip, however, seemed fully equal to any emergency; and by great energy, tact, and judgment, may, during his five years of office, be said to have founded the colony on a solid basis. Whatever may be the abilities of the best of the governors who succeeded him, to none should the colony feel a deeper debt of gratitude than to Arthur Philip.

At the end of 1797, the live stock of the colony consisted of 84 horses, 327 head of cattle, 4,247 hogs, 2,457 sheep, and 2,276 goats.

To Captain John McArthur, the colonies are indebted for the importation of a class of fine wooled sheep, which have been an inexhaustible source of wealth. By his energy and foresight, against much opposition, he established the pastoral interests of Australia.

It would be tedious to follow the colony through all its vicissitudes of prosperity and adversity, and its various political and domestic changes, during the first half of the present century.

At the end of 1860, the aggregate population of all the colonies was 1,124,477; revenue, £5,170,563; imports and exports, 47,367,126. New South Wales, cut down to its present boundaries at that date possessed—sheep, 6,119,163; cattle, 2,408,586; horses, 251,497; and the export of wool amounted to 12,809,363 pounds. The revenue, exclusive of loans, was £1,308,925, and the expenditure, including interest on loans, was £1,312,777.

The imports for the 10 years, 1851-60 (this includes Queensland), was above £5,000,000 per annum, or £52,822,249. The export for the same period was £39,327,726, or a trifle less than £4,000,000 annually.

At this time 7,170,690 acres of land only had been alienated.

The public debt was then £3,830,230; and the population 350,860.

The deposits in the 17 savings' banks were £557,196. The banks held, as deposits, £5,164,011.

Their coin being £1,578,424; bullion, £90,052; landed property, £239,050.

In 1874, the sheep were 22,872,882; cattle, 2,856,699; horses, 346,691.

The export of wool was 87,500,000 pounds,

and valued at	£5,651,643
Live stock exported, valued at	1,191,298
Tallow, skins, and leather	306,210
Preserved meat	73,712
	£7,222,863

The imports were £13,500,000 per annum; the exports were £13,671,581.

The savings' bank deposits were £1,295,000; the

bank deposits were £14,542,868; the revenue of 1875 amounted to £4,121,995; the expenditure, £3,415,650, leaving a surplus of £706,345, to which add the surplus of 1874, £910,613, gives a surplus in hand of £1,616,958.

At the end of 1876 this surplus is estimated at nearly £2,500,000, and the estimated deferred payments for land, which, at the end of 1875, was £5,000,000, will, by the end of last year, have been greatly increased. The public debt is £11,759,519 9s. 2d., and, as a commercial transaction, the two items—accumulated surplus revenue and deferred payments—could be made to pay off more than half this debt.

Up to 1870, the land sales averaged about £250,000 annually. The sales were in 1873, £774,000; 1874, £1,048,000; 1875, £1,627,000; 1876, 2,250,000; but whilst this rapid increase in the gross sales of land was taking place, there was an equally rapid increase in the charges of the lands department. As applicable to these sales of land the increase above the cost of the same, in 1871, was in 1874, £75,152; 1875, £151,825; 1876, £196,535.

It has generally been considered, but, to my mind, erroneously, that the railways do not pay anything towards the interest on the capital expended on their construction. This amount, to the end of 1876, was £8,596,000, out of which work not yet opened had cost £600,000. It may, therefore, be said that £8,000,000 had been expended,

The estimated net revenue for last year was £356,000, being slightly less than $4\frac{1}{2}$ per cent. The Post-office in 1876, left a loss of £94,000, but this was paid out of revenue.

The telegraphs have cost nearly £400,000, and not only give no interest on this amount, but leave a loss of £24,000 annually.

The duty on spirits, in 1872, was £368,000, since which the population has increased one-fifth, and it is found that the revenue has increased in an equal ratio, giving £442,000 for 1876. This statement I regret to be compelled to make.

There can be no dispute as to the rapid advancement and prosperity of New South Wales, from its first establishment, or even since her last child, Queensland, was taken from her.

The drought from which the colony has been suffering, more or less severely during the past three years, will cause immense loss of sheep and cattle, but this disaster, although it may ruin individuals, will only slightly retard, but not permanently injure, its general prosperity.

To evidence the richness of the country, I need only give in their rotation of relative value the exports for 1875:—

Wool	£5,651,643
Gold	2,094,505
Live stock	1,191,298
Coal	671,483
Tin	521,920
Copper	298,224
Hides, leather, boots and shoes	242,940
Grain	150,206
Tallow	111,522
Preserved meats, &c.	73,712
Timber	69,839
Other Articles	417,257
	£11,494,549

The imports for the same year being £13,490,200, together in round numbers, £25,000,000, as against £9,000,000 in 1860, nearly trebling in the fifteen years, while the population had only increased from 350,860 to 628,000, thus not quite doubling itself in the same period.

The greatest want of the colony is a steady increase of population, chiefly of the agricultural classes, and enterprising men with small capital, of the mechanical and shopkeeping class, and likewise, female servants are, at all times, greatly in request. The colonists are wise in strongly opposing Chinese, Malays, South Sea Islanders, or East Indians as immigrants, as these can, at best, only serve a temporary purpose, leaving in the future an offspring utterly worthless. The Chinese carry off all they make, and never work for others so long as they can work for themselves.

The communications between the colony and Europe, Asia, and America, have greatly improved, not only by the aid of fast sailing and auxiliary screw vessels, but the Peninsular and Oriental Company eastward, and the Pacific Mail Company westward, deliver mails and carry passengers each way, with the greatest regularity, in about forty-four days. Steamers are now running, *viâ* the Cape of Good Hope, in the same time. These latter I regard as of the highest possible value to Australia, as in the future they will stimulate a steady flow of immigration into the Colonies. The other two lines serve best for postal purposes, and to keep up communication with other portions of the globe.

The system of national education is that chiefly encouraged, but aid is largely given to the denominational schools, and, considering the scattered nature of the population, much good is being done by both. There is at Sydney a good university with three affiliated colleges, and a grammar school.

The schools under the Council of Education exceed one thousand, and the scholars in 1865 were 53,453, in 1874 were 119,133, in 1875 were 127,756.

The social peculiarities of the inhabitants of New South Wales are like those of all small British communities with most of their good and many of their weak points. Both the boys and girls are quick and self-reliant, but frequently wanting in application.

As a community they differ from the other Australian colonies in being perhaps less boastful, and too often depreciating their own colony and deploring the present times, but under this depreciation they have a strong love for their particular piece of Australia and especial admiration of Sydney and Sydney Harbour. This love of their colony is a great trait in their character, and will no doubt forcibly conduce to the retention and settlement of the wealthy-born in their own colony.

COMMERCE OF RHODES.

The principal imports are cotton, silken, and woollen manufactured goods, printed calicoes, cotton twist, coffee, sugar, leather, metals, rice, petroleum, soap, salt fish, &c. The exports are sponges, onions, wax, wine, storax oil, fruits, vegetables, &c. Sponges, which form one of the principal articles of export, amounting in 1876 to £140,000, had reached the prices paid some five or six years ago. This increase in the value of sponges is not due to any deficiency in the crop, which, on the contrary, was rather abundant, but to the comparatively small stock remaining in hand, and to the great demand in Europe. It was stated in a former report by Vice-Consul Biliotti, that all sponges sent from these islands to the market of Great Britain were always sanded (10 lb. of sand may be introduced in 1 lb. of sponge), and, therefore, overcharged with extra expenses of at least 10 to 12 per cent. for sanding, Custom-house dues, and freight in extra weight, and further extracting the sand. English merchants being accustomed to buy the sponges with as much sand as may be introduced in them, will not pay a proportionately higher price for those containing a lesser quantity. The same system was likewise formerly current in France, Austria, and other markets of Europe, but experience has shown that the best way of avoiding the expenses incurred by buying sanded sponges, was to purchase them from first-hand, that is to say, from the divers or owners of sponge-fishing boats in these islands. Agents of different merchants from France, Austria, and other markets, are now yearly sent

to effect purchases in Rhodes and the neighbouring small islands of the Sporades. This year, for the first time, two or three English merchants have also adopted the same system of buying from first-hand, and it is to be presumed that they will send to Great Britain unsanded sponges, thus avoiding the 12 per cent. extra expenses mentioned above.

The condition of the rural population is very precarious under the most favourable circumstances of the harvest. The agriculturist is believed to be the poorest of all the inhabitants of the island. He is very often without the most necessary means of living, and has not even the requisite seed for sowing his fields at the proper season. He is placed in the alternative either of remaining without any crop, and thus losing his chance of a year's income, or of having recourse to loans at usurious rates of interest.

NOTES ON BOOKS.

Experimental Researches in Pure, Applied, and Physical Chemistry. By G. Frankland, Ph.D., D.C.L., F.R.S., &c. London, 1877. J. Van Voorst.

This large volume, of more than 1,000 pages, contains the records of Dr. Frankland's thirty years' experimental work—papers collected from the various transactions and periodicals in which they first appeared. In the main they appear to preserve their original form (the date of their first appearance is in all cases given) but they are arranged in order of subjects in chapters, and to each chapter is prefixed an introduction, sometimes prefatory, sometimes explanatory, and sometimes bringing down to a later date the history of the researches treated in the papers which compose the chapter.

Not quite half the book is devoted to pure chemistry. This section commences with an account of the system of notation employed by Dr. Frankland, originally read as a paper before the Chemical Society in 1866. The subjects of the other chapters are:—"The Transformation of Cyanogen into Oxatyl," "The Action of Potassium upon Ethylic Cyanide; Polymerization of Ethylic Cyanide," "The Isolation of the Alcohol-Radicals," "Synthetical Researches on Organo-metallic Bodies," "Researches on Organoboron Compounds," "Synthetical Researches on Acids of the Lactic Series," "Synthetical Researches on Acids of the Acrylic Series," and "Synthetical Researches on Acids of the Fatty or Acetic Series," with a chapter headed "Miscellaneous Work," and comprising several short papers on different subjects.

The second section on "Applied Chemistry" occupies nearly as much space as the first, and it is here that we find subjects which are more kindred to the general topics of this *Journal* than among the pure science researches of Part I. With a final chapter on "Miscellaneous Work" there are three chapters on—(1) "Artificial Light," (2) "Drinking Water," (3) "Purification of Foul Water." The first two papers of the first chapter treat of the manufacture of hydrocarbon gas, and of the igniting point of coal gas. Neither of these are of very recent date. The results which Dr. Frankland puts forward as worth notice in connection with the first paper, are, that in London, notwithstanding the ostensible increase of illuminating power in the gas supplied from twelve to sixteen candles, the actual illuminating power was the same in 1876 as in 1851, the apparent improvement being due to the improved burner used in testing. To try this, special experiments were made in 1876 by Dr. Frankland's directions, in one of which gas, burnt at the rate of 5 ft. per hour, gave a light equal to 11·1 candles with the 1851 burner, and 14·3 candles with the present Referees' burner. The results obtained in the second research showed that coal gas ignites at a much lower temperature than marsh gas, and that the Davy lamp, which is a protection in explosive mixtures of air and fire-damp, is not safe in similar mixtures of air and coal gas.

The third paper in this chapter discusses the possibility of making metallic magnesium available as a source of light. It is found that, with an equal absolute thermal effect, burning magnesium gives 265 times as much light as gas. Prof. Frankland makes a calculation of the relative cost of ten hours' light from magnesium, stearin candles, and coal gas. At the present price of these, 2½ oz. of magnesium would cost £1 6s. 3d; 20 lbs. of stearin candles would cost £1; and 404 cubic feet of coal gas would cost 1s. 9½d. It is, however, suggested that a large demand for magnesium might reduce its price to about 2s. per ounce, in which case the cost of the above amount would be 5s. The real objection to magnesium is that the product of its combustion is solid calcined magnesia, which pervades the air of the room, and, in any quantity, would soon render it unbearable. This is acknowledged to be a fatal objection, unless, by some suitable air filter, the escape of the magnesia could be prevented, or the lamp were otherwise ventilated.

The remaining paper of this chapter is on an improved gas burner. The principle of this is that the burner has two concentric chimneys. The outer one extends to a short distance below the other, and is entirely closed below. The inner chimney is the ordinary Argand lamp chimney, and fits on a burner, &c., of the ordinary argand type. The effect of the arrangement is that the air to feed combustion is drawn down the annular space between the two chimneys, and is thus heated. The air passing over the gas pipe leading to the burner also heats the gas therein, and the result is that the temperature of the flame is considerably raised. The stated effect is that with equal amounts of gas 67 per cent. more light is given, or with equal light 49 per cent. of gas is saved. This paper is dated 1854, but it is said that the burner has never come into general use.

The memoirs in Chapter II. on drinking water are "On the Analysis of Potable Waters," "On a Simple Apparatus for Determining the Gases Incident to Water Analysis," "On some Points in the Analysis of Potable Waters," "On the Development of Fungi in Potable Water," "On Potable Water," "On the Softening of Hard Water," "On the Deterioration of Potable Water by Transmission through Mains and Service Pipes." All these grew out of Dr. Frankland's work in connexion with the analyses of London water which have since 1865 been conducted by him, and his work as a Commissioner on the Pollution of Rivers. The first papers describe the methods of water analysis elaborated by Dr. Frankland for application to the metropolitan water-supply, and the improvements in them suggested by experience, as well as other experimental researches doubtless suggested by this work. The later papers deal with the work performed chiefly in the laboratory of the Rivers Pollution Commission; indeed the last two papers are extracted from the 6th Report of the Commission (1874). The memoir on "Potable Water," which immediately precedes these extracts from the report, was communicated to a German chemical journal, and deals with the comparative purity of water from different sources of supply, and with the extent to which polluted water can be purified by various means. From the experimental data given, Dr. Frankland arrived at the opinion that, "there is no river in the United Kingdom long enough to purify its waters spontaneously if they have once became contaminated with sewage." The paper on softening hard water discusses the various methods of effecting this object, states its advantages, and enumerates tbe towns now supplied with hard water, showing the extent to which in each case the water would be softened by the application of the process. The last paper of the

chapter shows that badly laid mains, with hemp-packed joints, may pollute water continuously for years, whereas with properly laid mains the deterioration is *nil*. As regards lead pipes, it is stated that, even with water which acts violently on lead, there is no risk, except when the service pipes are new, and even then not very much. A very few slight cases of lead poisoning have been observed in Manchester and Salford during an experience of twenty-four years, and none at all in Glasgow since the introduction of Loch Katrine waters, fourteen years ago. Both these waters act violently on untarnished leaden surfaces.

Chapter IV., on "The Purification of Foul Water," may be taken as an account of the work of the Rivers Pollution Commission. It, in the main, consists of excerpts from the Reports, while the introduction gives a summary of the events which led to the appointment of the Commission, and of the results at which the Commission arrived. The only portion of the chapter not connected with this are two earlier papers, one treating of the results of an examination by Dr. Hofmann and the author into the various methods of sewage purification in 1859, when the state of the Thames called public attention forcibly to this question, and one on the use of perchloride of iron in arresting putrefaction in sewage. The conclusions arrived at by the Commission are obviously familiar to all interested in such questions, and were they not, a brief notice like the present would be no place in which to treat them. Suffice it to say that, in his re-published papers, Dr. Frankland insists on the necessity of disposing of the sewage by irrigation, if possible, over large surfaces, if not, by the system of downward intermittent filtration. Of the various chemical processes which came before the Commission, they say:—"It would obviously be rash to set any bounds to the possibilities of chemistry. Substances may perhaps be hereafter discovered capable of continuing with and rendering insoluble the filthy constituents of our town drainage; but we are compelled to admit that the present resources of this science hold out no hope that the foul matters dissolved in sewage will be precipitated and got rid of by the application of chemicals to the offensive liquid. The chemical affinities of these foul matters are so feeble, and the matters themselves are dissolved in such enormous volumes of water, that their precipitation is a problem of extreme difficulty." As regards the midden system, it is shown that the rivers are hardly less polluted where it exists, and that the ammonia of the sewage finds its way to the rivers almost as readily as where water-closets are in use. The difficulty, therefore, of obtaining the valuable parts of the sewage undiluted by water is lessened, not removed, by the employment of middens.

The fourth chapter is on "Miscellaneous Work." The first paper describes a method by which Dr. Frankland obtained an artificial human milk from cows' milk, by removing a portion of the casein, and adding a proportion of milk sugar. The remaining papers are on "The Influence of Atmospheric Pressure upon the Burning of Time Fuses," "On the Gases Existing in Solution in Well Waters," "Results of the Analysis of Eight Samples of Sea-waters collected during the Third Cruise of H.M.S. *Porcupine*," and "On the Transport of Solid and Liquid Particles in Sewer-gases." The experiments detailed in the last-named paper show that "although the agitation of a liquid by violent stirring does not throw up particles sufficiently fine to remain suspended in the air, the result is very different when liquid is agitated by effervescence due to the generation of gas. Hence it is inferred that the zymotic particles of sewage are not likely to become suspended in the air of a sewer unless the sewage be disengaging gas by its putrefaction."

The third section of this book, devoted to physical chemistry, consists of four chapters, "The Influence of Atmospheric Pressure upon Combustion," "The Spectra of Gases and Vapours," "The Source of Muscular Power," and "On Climate."

The Almanac and The Year-book of Photography. 1878.

Under these two titles are published—the first by the proprietors of the *British Journal of Photography*, and the second by those of the *Photographic News*—the two annuals at the head of this article. It is, perhaps, not generally known that the photographic world is sufficiently influential and extensive to support two special journals, issued weekly, devoted exclusively to photographic matters. They contain articles both of a practical and scientific character. Each at the commencement of the year brings out, under the above titles, that which was originally a simple almanac for the use of its subscribers, but which has grown from year to year into a goodly volume, enriched by contributions from most of the leading photographers, and with summaries by their respective editors of all that has taken place of interest connected with the art during the past year. Each, too, is illustrated by work produced in permanent tone by the Woodbury-type process, showing the perfection to which this branch of the art has attained. The subjects touched upon are too numerous to be named in detail; suffice it to say, that there is scarcely a matter of interest, or any novel fact, connected with photography, which does not find some mention made of it.

GENERAL NOTES.

Edinburgh Sanitary Protection Association.—An attempt is being made by some residents of Edinburgh to apply the co-operative principle to scientific sanitary inspection. They are endeavouring to organise an association, the annual subscription to which will be one guinea, for the purpose of securing to its members free of charge that skilled sanitary supervision and advice which could only be got at considerable cost through individual action. The association is to secure the exclusive services of one or more well educated young engineers, who, acting under the control of a consulting engineer of high standing, will, when required, inspect and report upon the dwellings of members, giving estimates as to the cost of any alterations that may be deemed advisable. They will also examine and report annually, to make sure that the houses are not only brought into a good sanitary condition, but remain so. Their recommendations must be limited to strictly indispensable points, and no officer of the association is to hold any pecuniary interest in any patent or manufacture. The Professor of Engineering in the University of Edinburgh (Mr. Fleeming Jenkin) is the originator, and one of the most active promoters of the scheme, and he has offered for the first year to give the association his gratuitous services. Another feature of the scheme is that each member, on payment of a trifling fee, may secure the services of the officials for any charitable society whose work in individual cases might be aided by them, or for any person in whom they are interested, who, though deserving, is too poor to obtain for himself good sanitary advice.

Technical Education.—The Goldsmiths' Company, with a view to the encouragement of technical education in the design and execution of works of art in the precious metals, offer their annual prize of £50 for the best design, and also £50 for the best model of some article in gold and silver, which, when manufactured, shall exceed 30 ounces in weight; an annual prize of £25 for the best execution and workmanship of some such article; three prizes of £25 for the best design, model, and execution of some article of less weight than 30 ounces; and prizes of £25 each for the best specimens of chasing or *repoussé* work and engraving. Objects of jewellery and personal ornaments are not to be the subjects of design. All the specimens sent in will probably afterwards be publicly exhibited. The competitors must be British subjects, and the objects must

be delivered before November next. The company have also resolved that a travelling scholarship of £100 per annum may be awarded to a student who has shown exceptional talent, and who shall have obtained a prize for design for three successive years, in order to enable him to study art in the precious metals on the Continent.

Index Society. — At a meeting held on Friday, October 26th, 1877 (Mr. Robert Harrison in the chair), it was resolved to found a society to be called the Index Society, for the purpose—1. Of forming indexes to standard works at present without them, and of enlarging and re-editing indexes already made. 2. Of compiling subject indexes of science, literature, and art. 3. Of accumulating materials for a general reference index. The honorary secretary, *pro tem.*, is Mr. Henry B. Wheatley, 5, Minford-gardens, West Kensington-park, W.

Application of Teazel Stems for Parasol Handles.— An entirely new commercial article has quite recently arrived in this country from France, in the shape of a curiously twisted stem. This stem, which is flattened and spirally twisted, and marked with deep corrugations or channels, proves to be that of the Fuller's Teazel (*Dipsacus Fullorum*), a plant very much cultivated in Southern France and Austria for the sake of its prickly flower heads, which are so extensively imported into this country for carding or raising the nap on cloth. Hitherto, the only application to which the stems have been put have been for fuel, or for manuring the ground after they have been allowed to rot. Their present use is for the handles of ladies' sun shades, and when manipulated they have a very grotesque and striking appearance. Several thousands of these fasciated teazel stems are now in England, and are in the hands of Messrs. Marshall and Snelgrove, the well-known West-end silk mercers, from whose establishment they will issue as a novelty during the coming season. At a recent meeting of the Linnean Society, some of these fasciations were shown as imported, as well as a finished parasol with a teazel handle, sent by the firm who intend bringing them out. At one time these fasciated stems were supposed to be very rare, but from the fact of so many being now introduced they would seem to be of common occurrence.

Loupes.—This article of trade is much sought after in the mountains separating the Caspian provinces from Irak, or Persia proper. As is well known, *loupe* is the French term for the great burrs, wens, or excrescences on trees, from which the handsome veneers are cut, for inlaying fancy furniture. Walnut, maple, wainscot oak, and other cabinet woods yield these finely marked curled excrescences. It is only produced in the highlands, where it may be purchased at a very low rate; but, owing to the labour attending its transport in a country destitute of means of communication, it costs too much for speculative purposes to bring it down to the ports of shipment. Some good specimens of this valuable excrescence were, notwithstanding, brought down last season. The best marked samples of this wood are sent to England, *via* Tiflis, while the ordinary quantities suit best the French market. Some loupes are to be found weighing upwards of a ton, but, owing to the want of means of transport, they have to be reduced in size. It would repay curiosity to witness the process by which these hard blocks of timber are cut up into sheets almost as thin as writing paper, for veneering purposes. The loupe is introduced into a large receptacle, and steamed for several days consecutively, until, from the adamantine hardness it naturally possesses, it assumes the consistency of cheese. It is then placed under a machine, which, with a large blade, slices it off into sheets, which harden by exposure and are sold in the market according to size and beauty of design; some loupes, in Paris, have fetched as much as £800 sterling.—*Consul Churchill's Report.*

NOTICES.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at eight o'clock. The following arrangements have been made:—

February 6.—"Higher Commercial Education." By John Yeats, Esq., LL.D.

February 13.—"The Systems of Cremation in Use upon the Continent." By W. Eassie, Esq. Higford Burr, Esq., will preside.

February 20.—"The Steam Tramways of Paris," by J. L. Haddan, Esq., M.I.C.E. Col. Beaumont, R.E., will preside.

February 27.—"The Past, the Present, and the Future of the River Thames." By J. B. Redman, Esq.

March 6.—"An Electric Lamp-lighting System." By St. George Lane Fox, Esq.

March 13.—"The Type-writer." By R. Brudenell Carter, Esq., Member of the Council of the Society.

March 20.—"Emery and Corundum Wheels for Grinding and Surfacing Metals and other Materials." By A. H. Bateman, Esq., F.C.S.

March 27.—"Musical Education at Home and Abroad." By Alan S. Cole, Esq.

April 3.—"Our Wealth in Relation to the Imports and Exports of the Country," by E. Seyd, Esq.

African Section.

Tuesday evenings, at eight o'clock. The following arrangements have been made:—

February 19.—"Egyptian Obelisks and their Relation to Chronology and Art." By Basil H. Cooper, Esq., B.A. Admiral Sir Erasmus Ommanney, C.B., F.R.S., will preside.

Indian Section.

Friday evenings at eight o'clock. The following arrangements have been made:—

February 1.—"The Destruction of Life in India by Wild Animals." By Sir Joseph Fayrer, M.D., K.C.S.I. Sir George Campbell, M.P., K.C.S.I., D.C.L., will preside.

February 22.—"Irrigation Regarded as a Preventive of Indian Famine." By W. T. Thornton, Esq., C.B.

March 15.—"The Colonisation of Hill Districts in India." By Lieut.-General McMurdo, C.B. Edwin Chadwick, Esq., C.B., will preside.

March 29.—"The Depreciation of the Value of Silver, with Especial Reference to the Exchange between India and England, and Suggestions for a Remedy." By Col. J. Smith, R.E., late Superintendent of Madras Mint.

Chemical Section.

Thursday evening at eight o'clock, The following arrangements have been made:—

February 14.—"Recent Improvements in the Metallurgy of Nickel." By A. H. Allen, Esq., F.C.S.

February 28.—"The Chemistry of Infection, or the Germ Theory of Disease from a Chemical point of View." By C. T. Kingzett, Esq., F.C.S.

Additional Lectures.

A Course of Three Lectures, on "Explosions in Coal Mines," is now in course of delivery, by T. Wills, Esq., F.C.S. The remaining lectures will be delivered on Mondays, at Eight o'clock, February 4th and February 11th.

Lecture II.—February 4th.

After-damp or choke-damp. Methods adopted to allow of safe working in fiery mines. Various appliances for lighting mines. The nature of the safety lamp. Different forms of this lamp.

Lecture III.—February 11th.

Connection of the variations of atmospheric pressure with explosions in coal mines. Dangers attending blasting operations in coal mines. Action of coal-dust in certain classes of explosions. The use of the safety lamp as an indicator of the presence of fire-damp, also as a means for its quantitative estimation.

Cantor Lectures.

Monday Evenings, at Eight o'clock. Second Course, on "The Application of Photography to the Production of Printing Surfaces and Pictures in Pigment." By Thomas Bolas, Esq., F.C.S.

Lecture I.—February 18th.

Photo-lithography and photo-zincography.

Lecture II.—February 25th.

Phototypic, or raised printing blocks, by swelled gelatine process, zinc etching, and other methods.

Lecture III.—March 4th.

Line engraving on metal plates.

Lecture IV.—March 11th.

Printing of half-tone subjects from metal. Application of Asser's process. Talbot's Photo-engraving. Woodbury's methods for engraving and printing.

Lecture V.—March 18th.

Collotypic printing.

Lecture VI.—March 25th.

Other methods of producing photographs in pigment. Dusting-on method. Autotype printing.

Third Course, on "Some Researches on Putrefactive Changes, and their Results in relation to the Preservation of Animal Substances." By B.W. Richardson, Esq., M.D., F.R.S. April 8, 15; May 6, 13, 20, 27.

MEETINGS FOR THE ENSUING WEEK.

Mon..... **SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Additional Lectures.) Mr. Thomas Wills, "Explosions in Coal Mines." (Lecture II.)
Farmers' Club, Caledonian Hotel, Adelphi, W.C., 5½ p.m. Mr. T. Aveling, "Traction Engines for Agricultural Purposes"
Royal Institution, Albemarle-street, W., 2 p.m. General Monthly Meeting.
Society of Engineers, 6, Westminster-chambers, 7½ p.m. Inaugural Address by the President, Mr. Robert Paulson Spice.
Royal United Service Institution, Whitehall-yard, 8½ p.m. Sir William Thompson, "His New Compass and his Sounding Apparatus."
British Architects, 9, Conduit-street, W., 8 p.m. Mr. T. Brassey, "The Rise and Fall of Wages in the Building Trade."
Medical, 11, Chandos-street, W., 8.30 p.m. (Lettsomian Lectures.) Mr. Francis Mason, "The Surgery of the Face, Mouth, and Throat." (Lecture III.)
Victoria Institute, 10, Adelphi-terrace, W.C., 8 p.m. The Lord Bishop of Edinburgh, "Scientific Thought in relation to Religion."
London Institution, Finsbury-circus, E.C., 5 p.m. Mr. E. J. Reed, "The History of the Ironclad."

Tues.... Central Chamber of Agriculture (at the House of the Society of Arts), 11 a.m. Special General Meeting.
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Garrod, "The Protoplasmic Theory of Life and its Bearing on Physiology." (Lecture III.)
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Continued discussion on "Dynamo-Electric Apparatus," and, time permitting, Mr. J. A. Longridge, "The Evaporative Performance of Locomotive Boilers."
Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.
Biblical Archæology, 33, Bloomsbury-street, W.C., 8½ p.m. 1. Mr. William Simpson, "The Supposed Tomb of St. Luke at Ephesus." 2. Mr. J. T. Wood, "Antiquities of Ephesus having relation to Christianity, and the Sojourn of St. Paul in that city."
Zoological, 11, Hanover-square, W., 8½ p.m. 1. Mr. Patrick Geddes, "The Mechanism of the Odontophore in certain Mollusca." 2. Mr. W. A. Forbes, "Reports on the Collection of Birds made during the Voyage of the *Challenger*, No. VII. On the Birds of Cape York and the Neighbouring Islands." 3. Mr. Francis Nicholson, "A Collection of Birds from Abeokuta." 4. Prof. St. George Mivart, "Notes on the Fins of Elasmobranchs with Considerations on the Nature and Homologies of Vertebrate Limbs."

Wed.... **SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Dr. Yeats, "Higher Commercial Education."
Decimal Association (at the House of the Society of Arts), 4 p.m.
Geological, Burlington House, W., 8 p.m. 1. Prof. Owen, "The Influence of the Advent of a Higher Form of Life in Modifying the Structure of an Older and Lower Form." 2. Mr. E. Tully Newton, "Notes on a Crocodilian Jaw from the Coral Rag of Weymouth." 3. Mr. J. W. Hulke, "Note on Two Skulls from the Wealden and Purbeck Formations indicating a New Sub-group of Crocodilia." 4. Mr. Ernest Vanden Broeck, "Some Foraminifera from the Pleistocene Beds in Ischia." Preceded by some geological remarks by Mr. A. W. Waters.
Entomological, 11, Chandos-street, W., 7 p.m.
Microscopical, King's College, W.C., 8 p.m. Anniversary Meeting. President's Address.
Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.
Archæological Association, 32, Sackville-street, W., 8 p.m. 1. Rev. Prebendary Scarth, "Sculptured Effigy in Bothampton Church." 2. Mr. Stothard, "Ancient Cross near Penarth, Glamorgan." 3. Mr. R. E. Way, Coplestone Cross, Devon."
Obstetrical, 53, Berners-street, Oxford-street, W., 8 p.m.

Thur.... Royal, Burlington House, W., 8½ p.m.
Antiquaries, Burlington House, W., 8½ p.m.
Linnean, Burlington House, W., 8 p.m. 1. Sir John Lubbock, "Observations on the Habits of Ants, Bees, and Wasps." Part V. 2. Mr. Arthur W. Waters, "The Structure of the Shell of the Bryozoa." 3. Mr. Thos. Meehan, "The Laws Governing the Production of Seed in *Wistaria sinensis*"
Chemical, Burlington House, W., 8 p.m. 1. Dr. Paul and Mr. Kingzett, "Notes on the Tannins." 2. Mr. H. C. Jones, "A Method for the Determination of Boiling Points." 3. Dr. Wright and Mr. Luff, "The Alkaloids of the Aconite Family. Part II. The Alkaloids of Aconitum Ferox." 4. Dr. Gladstone and Mr. Tribe, "An Inquiry into the Action of the Copper-zinc Couple on Alkaline Oxysalts." 5. Mr. E. Riley, "The Estimation of Phosphorus in Iron and Steel."
London Institution, Finsbury-circus, E.C., 7 p.m. Lecture by Sir Edmund Beckett.
Society for the Encouragement of the Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. William Simpson, "Illustrated Journalism."
South London Photographic (at the House of the Society of Arts), 8 p.m.
Royal Institution, Albermarle-street, W., 3 p.m. Prof. Dewar, "The Chemistry of the Organic World." (Lecture III.)
Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.

Fri...... Women's Education Union (at the House of the Society of Arts), 3½ p.m.
Royal Institution, Albemarle-street, W., 8 p.m., Weekly Meeting. 9 p.m., Mr. Matthew Arnold, "Equality."
Astronomical, Burlington House, W., 8 p.m. Annual Meeting.
Quekett Microscopical Club, University College, W.C., 8 p.m.
Clinical, 53, Berners-street, W., 8½ p.m.

Sat...... Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.
Royal Institution, Albermarle-street, W., 3 p.m. Mr. Bosworth Smith, "Carthage and the Carthagenians." (Lecture III.)

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,316. Vol. XXVI.

FRIDAY, FEBRUARY 8, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

TECHNOLOGICAL EXAMINATIONS.

The Council have determined to add Telegraphy to the list of subjects in the Society's Technological Examinations.

The syllabus for the use of Candidates is now being printed, and will be issued shortly.

The first examination will be held in May next.

Mr. W. H. Preece has undertaken the duties of Examiner.

ADDITIONAL LECTURES.

The second lecture of the course on "Explosions in Coal Mines," was delivered by Mr. T. Wills, F.C.S., on Monday evening last, at eight o'clock. The lectures will be published in the *Journal* later on, probably during the Easter vacation. The remaining lecture of the course will be given on February 11th.

INDIAN SECTION.

Friday, February 1st, 1878; Sir George Campbell, M.P., K.C.S.I., D.C.L., in the chair.

The Paper read was :—

DESTRUCTION OF LIFE BY WILD ANIMALS AND VENOMOUS SNAKES IN INDIA.

By Sir J. Fayrer, K.C.S.I., M.D., F.R.S.

It has been suggested to me that some information on the destruction of life in India by wild animals and venomous snakes would be acceptable to the members of this Society; I have, therefore, put together a few notes on the subject, which will serve to show that, among the many preventive checks to population in that country, such as epidemics, famines, storm-waves, and cyclones, nature has yet another and very potent one, in the predaceous animals with which the forests, hills, plains, and waters still abound. I propose, then, to give you some account of the mortality caused by these creatures among our Indian fellow-subjects, to tell you something of the circumstances under which the deaths occur, and to add a brief description of the animals that destroy 20,000 human beings, and 50,000 head of cattle annually. This yearly loss of human life and cattle is startling, and suggests the question whether some more effective measures than any now in operation might not diminish it. The subject has long been under consideration by the Indian Government, and the object of legislative interference, but, as I shall presently show you, with no very satisfactory results; and, that, notwithstanding the measures taken, the destruction of life still goes on at what has been described as really "an appalling rate."

It appears from the returns furnished to Government, that, in the year 1875, 20,805* persons and 46,805 head of cattle perished from this cause, and that the deaths were due to the following animals: —Elephants killed 61 human beings and six head of cattle; tigers, 828 persons and 12,423 cattle; leopards, 187 persons and 16,157 cattle; bears, 84 persons and 529 cattle; wolves have a bad pre-eminence, for they destroyed 1,016 persons and 9,407 cattle; hyænas are responsible for the death of 68 persons and 2,116 cattle; whilst jackals, alligators, buffaloes, boars, and other animals, are charged with the destruction of 1,446 persons and 3,001 cattle, whilst snakes killed 17,070 persons and 3,166 cattle.

In 1875, Bengal lost 10,914 persons; the North-West Provinces, 3,933; Oude, 1,736; Madras, 1,536; Bombay, 1,072; Punjab, 723; Central Provinces, 617; Assam, 420; Burma, Hyderabad, Ajmeer, and Mairwarra contributing the balance; and there is reason to suppose that even these returns fall short of the real mortality in respect of some of the localities, whilst from others, such as some of the independent States, no returns at all have been obtained, and all this notwithstanding the destruction of a large number of wild animals and snakes. For in the same year, 1875, it appears that 22,357 wild animals, and 270,185 snakes were destroyed, at a cost to Government of 120,016 Rs.

In 1876, it appears, from the *Gazette* supplement, of November 24th, 1877, that there was some diminution in the loss of human life, but an increase in that of cattle; 19,273 persons, and 54,830 head of cattle were killed. But as the returns were not complete, those from Mysore and Coorg not having been sent in, the comparison with the previous year is not complete. The resolution by Government on the report says, "In Madras, Bengal, North-West Provinces, and Oude the numbers of persons killed by wild animals and by snakes are less in 1876 than in 1875. In the other provinces the figures do not exhibit any great variation, except in the Central Provinces, where deaths rose from 617 in 1875, to 1,098 in 1876."

No explanation is offered of the greater mortality. As regards the loss of cattle, the figures of the year are unsatisfactory; while Madras and Bombay show fewer cattle killed, Bengal, the North-West Provinces, Oude, Punjab, Central Provinces, and British Burma show materially

* The totals given in the Government returns for 1875, are:—Men, 21,391; cattle, 48,234; but there seems to be some error in the addition, which should be—men, 20,805; cattle, 46,805. A similar error occurs in the addition of the returns of 1876—men, 19,273; cattle, 54,830; should be—men, 18,273; cattle, 54,430.

large numbers; and it is probable that the figures are only approximative, as the agency for reporting is still imperfect. The unfavourable figures, it may be, testify to better reporting.

During this year 124,574-4-6 Rs. were paid for the destruction of wild animals and snakes, as against 120,016 Rs., of 1875.

The following summary of the Madras and Bombay reports, gives the results of 1876:—

Wild Beasts and Snakes in Madras.—The Board of Revenue have submitted to Government their report on the results of the measures taken for the destruction of wild beasts and snakes during the year 1876. The number of elephants killed was 2, tigers 236, leopards 844, cheetahs 177, bears 133. The number of tigers killed in 1876 was about the same as that in 1875. Most of them were killed in the Northern Circars, Malabar, and Coimbatore. Leopards and cheetahs.—The total number killed in 1876 was 1,021, against 918 in 1875. Of the 133 bears killed, 107 belong to the Northern Circars. The number killed in 1875 was 154. The number of wolves killed was 39, exactly the number killed in 1875. The total number of hyenas destroyed was 164, against 139 in 1875. The total number of other animals killed was 4,741, against 5,302 in 1875. No reward is granted for the destruction of snakes, and as a consequence the number killed is probably not correctly reported. The number reported, however, is 532, against 3,075 in 1875. The total loss of human life by wild animals and snake-bites was, if the reports are to be trusted, considerably less in 1876 than in 1875. The returns show only 162 deaths in 1876, against 268 in 1875, by wild animals; and 819 against 1,268 by snake bite; but the Board apprehend that the number reported is not trustworthy. The loss of cattle was 10,322, against 11,934 in the preceding year; that caused by tigers, leopards, and wolves, being respectively 3,231, 2,235, and 3,681.*

Deaths from Animals in India.—A statement has been published in the *Bombay Gazette*, showing the results of the measures adopted in British India with the view of exterminating wild animals and venomous snakes, during the year 1876. As will be perceived, snake-bites are far in excess of all other causes of death. The number of persons killed by elephants was 52; by tigers, 917; leopards, 156; bears, 123; wolves, 887; hyenas, 49; other animals, 143; snakes, 15,946; total killed, 19,273. Number of cattle killed by elephants, 3; tigers, 13,116; leopards, 15,373; bears, 410; wolves, 12,448; hyenas, 2,039; other animals, 4,573; snakes, 6,468; total killed, 54,830. Number of animals and snakes destroyed and amount of reward paid for their destruction: Elephants, 4, Rs. 50; tigers, 1,693, Rs. 43,598-12; leopards, 3,786, Rs. 33,972-12; bears, 1,362, Rs. 4,915-6; wolves, 5,976, Rs. 18,633-12; hyenas, 1,585, Rs. 3,650-12; other animals, 8,053, Rs. 3,985-2; snakes, 212,271, Rs. 15,757-12-6; total number, excluding snakes, destroyed, 23,459; total amout of reward, including snakes, Rs. 1,24,574-4-6.†

Now, it seems obvious that more effectual measures are needed to mitigate, if not prevent, this evil. There is reason to believe that the supreme Government has the matter under its anxious consideration, with a view of devising plans by which, with the most efficiency and at the least cost, the evil may be remedied. But I fear the expenditure of more money is needed to make any arrangement competent to grapple with the evil. I shall presently tell you briefly what measures are in force, and offer a few suggestions as to how a scheme for dealing with it might be worked out.

* *Madras Times*, October 4, 1877.
† *Allan's Indian Mail*, 29 Dec., 1877.

The question that it concerns us to ask is, how may this mortality be diminished, and what measures might be resorted to for mitigating what should be, to some extent certainly, a preventible evil. It is one by no means easily dealt with, and though, no doubt, Government aid is needed—indeed, is essential in a country like India, where Government is expected to do almost everything—yet it is necessary that the people should bestir themselves, trust to their own resources, and be more self-reliant in this as in other matters concerning their social welfare, before the evil can be removed, or stayed. Nor can it ever be so entirely whilst predaceous animals continue to abound. As Shakespeare says, "Tigers must prey!" and, so long as these *feræ naturæ* are numerous, cattle or men will be their victims. The Government may give rewards for the destruction of noxious animals, but the people must learn to protect themselves, and to bring the resources of improved knowledge and civilisation to bear on this and other matters that concern their well-being. As education makes them more self-reliant, and clears away prejudices and superstition—as civilisation produces increase of cultivation, and a more general diffusion of humanising influences—wild beasts will recede, and men will no longer worship, or reverence with superstitious awe, the creatures that destroy them. Meanwhile, one cannot help thinking that something more should be done to prevent such destruction of life.

The death-rate from disease has been reduced to less than one-third of its former figure (69 to 18) by the scientific application of sanitary laws. Let the same enlightened attention be given to this death cause, and depend on it, equally good results would, in time, ensue. In a few years, it would no longer be the duty of the registrar to chronicle such figures of mortality as those I have given you. Without concerning ourselves with what obtained previous to 1868, I will tell you chiefly what has been done since then. I have selected from the *Indian Gazette* a small portion of what is recorded, but sufficient to show the extent of the evil and that it is appreciated both in India and England.

Towards the close of the year 1868, a scheme submitted by the late Captain Rogers, of the Bengal Staff Corps, for the destruction of wild animals, and a suggestion by the Foreign Department for the revision of the existing system of rewards for such destruction, led to a review of the losses occasioned from year to year, both of life and property, by tigers, panthers, wild elephants, snakes, and other noxious animals, all over the country, with a view to the determination of the best means that could be adopted for their extirpation. No single report, however, was extant, which would give sufficient, if not complete, information on the subject; accounts of the depredations committed in the several provinces by beasts of prey being scattered over a variety of documents, such as survey reports, general administration reports, applications for sanction to the offer of rewards, special reports of missionaries residing in the interior, &c., &c. But the few papers that could be collected at the moment were enough to convince the Government that the annual losses of human life, and of cattle, and the injury to crops caused

by these scourges, were exceedingly great. Whole villages were at times completely depopulated, public roads and thoroughfares rendered literally unapproachable by human beings, even in broad daylight, and thousands of acres of once cultivated land were, in consequence, entirely deserted, and confined to the growth of brushwood and rank vegetation, to offer, in their turn, safe coverts to these various animals, and enable them to do more havoc in the surrounding country.

It appeared from the Central Provinces Revenue Survey Report for 1867-68, that great obstruction was caused to the operations of the survey party by the depredations of tigers which infested the district where it was employed. A tigress was represented to have killed 127 people, and stopped the traffic for many weeks on the road between Moolb and Chunda, until she was shot by an officer. In the Topographical Survey Report of the Bengal Presidency for 1867-68, it was stated that "in the Central Provinces the surveyor came across a track which had been utterly devastated by a single tigress, which was estimated to have killed upwards of 50 people, and was known to have driven the inhabitants away from 13 villages." Certain proceedings of the Madras Government that were laid before the Governor-General in Council, also contained terrible accounts of the ravages committed by tigers, leopards, and other wild animals. A report by the collector of South Canara, dated the 16th February, 1868, stated:—"The depredations caused by tigers and cheetahs have of late been somewhat serious in the district, and even the town of Mangalore itself is not free from their incursions. In the month of June, 1865, it was reported that during the previous twelve months no less than sixteen human beings had been carried off in the Udipi and Candapore Talooks, and in the rest of the district, the loss of life by this cause only was gradually on the increase. In addition to this, the losses by the villagers of their cattle, goats, and pigs were in some localities very considerable." The collector of Kurnool, under date the 9th October, 1867, reported that, up to the end of September preceding, a man-eating tiger had carried off no less than 64 human beings, and had caused such a terror that the post-runners and beat constables would not traverse the ghat until large numbers of persons collected together, and procured numerous tom-tom beaters to accompany them, and that the coolies of the Public Works Department had stopped work through fear of attack by this tiger.

The proceedings of the Government of the North-Western Provinces were also not wanting in horrible accounts of ravages committed by wild beasts. A report by the local Board of Revenue, dated 7th December, 1867, contained the following mournful narrative of the destruction of life caused by a single bear in a northern village bordering the forest:—"About midnight, whilst most of the cultivators were out watching their rubbee crops, and there were only some fourteen or fifteen people in the village, a bear, in the short space of two hours, killed two men, three women, and one child, also wounding two men. He first entered the house of one Ahmed Yar Khan, Pathan, and killed two women. He next destroyed Sobratee Dhobee, who had come to the assistance of the women. He then entered the house of Elahi Buksh, butcher, and killed his wife and child. The husband attacked him with a knife, but the bear appears (from investigation) with one blow to have torn away his head and face. On retiring from the village he attacked six head of cattle, three of which died before morning. The cries from the village attracted the attention of two of the cultivators, who, proceeding from their fields to ascertain the cause, met the bear a short distance outside the village. He immediately attacked them, wounding them both, but the wounds were not serious. The following night the animal entered the adjoining village of Pertabpore. He there entered the house of a 'Rais,' and wounded his wife; he then attacked the man, and had succeeded in wounding him badly on the arm, when he was shot by a man named Waly Mahomed."

The police reports of some of the provinces showed that the local governments and administrations were quite alive to the necessity of driving away these wild beasts from the vicinity of the habitations of men, and rewards were most liberally dealt out for their destruction. But enormous numbers of men, women, and children still continued to fall victims to their ravages year after year.

So early as March, 1864, the Secretary of State had noticed serious devastations caused by tigers, wolves, and other wild animals, and thought it not improbable that the failure of the handsome rewards offered for their destruction in producing the desired effect might be partly owing to the villagers having been deprived of their arms through the operation of the General Disarming Act. He, therefore, commended the subject to the consideration of the Government of India, and desired that, if deemed necessary, the inhabitants of those villages which suffered most from the ravages of wild beasts might be allowed to retain such arms as were absolutely necessary for the protection of themselves and their property. This despatch being circulated through the government of Bengal to the several Divisional Commissioners in the Lower Provinces, a discussion took place as to the adequacy or otherwise of the authorised rewards, resulting in some cases to an enhancement of them. The Bengal Government also suggested to the Commissioners that strychnine might be used with advantage, and without risk, by being introduced into the body of a cow or other animal after it had been killed by a tiger. But nothing was said in the correspondence that ensued to lead to the conclusion that the operations of the Arms Act had in any way contributed to aggravate the evils complained of.

A separate correspondence was at this time going on with the local governments and administrations on the subject of the Arms Act, from which it became abundantly manifest that the loss arising from the destruction of crops by wild elephants, pigs, &c., was very considerable.

Captain Rogers' scheme consisted of a contrivance devised by him, a sort of spring gun, already in use in many parts of the country. The main details of the invention are contained in his letter.

With regard to the weapon, he proposes the use of the old muskets, that have merely a nominal value as iron, and are constantly being taken up and sold as such.

Captain Rogers depicted in strong and vivid colours the immense and irreparable injury caused by wild animals in remote parts of the country, as will be seen from the following extract from his letter:—"By killing as they do these cattle, not only are the villagers losers, but also the Government in an indirect way." It is by these people, and these people, again, assisted by their live agricultural stock, that the vast jungles are becoming tracts of cultivated country; but the wild beasts greatly retard the same, and act as a considerable check on the energies of those unfortunates, who are now, to a great extent, at the mercy of any tiger or other beast of prey that may take up its quarters in their district.

No thefts or murders in India can exceed the horrors and misery caused by the wild animals, and no picture or language can give even a faint idea of the sufferings of their victims. Those poor creatures, living as they do, for the most part, in districts seldom or ever visited by any European except an occasional sportsman, are obliged to bear their losses or sufferings with little or no chance of the same being brought to the notice of the Government whose subjects they are. I now look upon it in the light of a question involving the lives of hundreds of persons yearly, and, in a second and less serious light, as affecting the loss of cattle to the value of many lakhs of rupees for the same period, and the same being almost entirely the only worldly property of thousands of half-starved creatures of a much more honest and truthful disposition than the inhabitants of the towns and villages in the immediate vicinity of our stations.

Captain Rogers would organise the shikarees of every district into regular bands, with jemadars over them, and supply them with guns and ammunition, exempting these selected shikarees from the usual payment for licenses for their guns. He said that, where bows and arrows were used by the natives, the same contrivance as that suggested by him would operate with fatal results in the destruction of wild animals. He would fix the reward at 8 Rs. only, "but never more, except under special circumstances, having no reference to the damage the tiger is doing, but to any extra trouble or injury the shikharee has sustained in killing it."

The total reported loss of human life in the three years of 1866-67, 1867-68, and 1868-69, from wild beasts and venomous snakes, was no less than 38,218,* or 12,736 per annum; and that the expenditure incurred by Government in rewards for the destruction of noxious animals amounted to 455,755 Rs., or 151,918 Rs. per annum. Bengal appears to have suffered most, upwards of 21,000 lives having been lost during the period; that is, nearly 5,000 more than the number lost throughout the rest of India. This certainly throws serious doubts on the accuracy of the returns from the other provinces. Next to Bengal, are the North-Western Provinces; Oudh, the Central Provinces, and Madras stand third, fourth, and fifth, respectively; British Burmah showing the least loss of all. As regards expenditure, the Central Provinces stand first in the list, having spent a lakh and 65,000 rupees; that is, nearly three times as much as Bengal. Next to the Central Provinces stands Madras, where the expenditure amounts to 80,000 rupees. Bengal stands third in this respect, having spent only 62,000 rupees; Punjab is fourth, and British Burmah has been the least expensive of all.

The excessive expenditure in the Central Provinces may be in some measure owing to the extremely high scale of rewards prevailing in these provinces. One hundred rupees for a "man-eating" tiger, and fifty rupees for a "full-grown" tiger, are not paid anywhere else. It may not be possible to secure uniformity in regard to the scale of rewards. But, presumably, the Government of India can, with great advantage, lay down a maximum limit for each species, on a consideration of the rates prevailing in the different parts of the country, leaving it to the local governments to propose higher rewards in the case of any specially destructive and dangerous animals.

None of the local governments suggest any specific measures for adoption beyond the system of rewards now in force; and almost all subordinate officers whom they have consulted agree in condemning Captain Roger's mechanism as unsuited to the territory under their jurisdiction, or as dangerous and full of risk to human beings and domestic animals. For a brief analysis of the opinions given by the local governments, the reports may be divided into three heads:—

1. The destruction of wild animals, and Captain Rogers' plan.
2. Destruction of poisonous snakes; and
3. Disposal of the skins of wild animals killed.

As regards the destruction of wild animals and Captain Rogers' plan, local officers in the Lower Provinces consider the system of offering rewards to be practically the best, and recommend no change in this respct.. The Lieutenant-Governor thinks that much good might be done by encouraging local officers in districts in which the loss of life and cattle is great, "to organise at suitable seasons, and at a small expense to Government, large hunting parties, to destroy the particuar class of beasts found to be destructive," as such a course would give the people courage, and incite them to organise similar hunts themselves, and also teach them to make a stand against a danger that is now destroying their substance and themselves. His Honour would also encourage the police to destroy noxious wild animals by allowing them the usual rewards.

The Madras Board of Revenue considers it "the bounden duty of Government to do something for the destruction of wild animals and the protection of life and property from their ravages," but does not think it necessary to depart from the present system of rewards.

The Government of the North-Western Provinces, writes:—"Upon the whole, the Lieutenant-Governor is of opinion, that the existing system answers well, and no material alteration need be recommended. Wherever there is any unusual prevalence of destructive animals, his Honour considers that the Government should have authority, as within budget limits it already possesses, to increase the rates of reward for their destruction. And where individual animals become notorious as occasioning loss of life, such as man-eating tigers and rogue elephants, liberal rewards should

* Wild beasts, 12,554; snakes, 25,664. Total, 38,218.

be offered on special parties organised for killing them." His Honour does not approve the adoption of Captain Rogers' plan. The use of poison is recommended by some officers, but it does not appear to have been anywhere adopted. His Honour considers that there is obvious danger in a resort to this practice, and is, therefore, unable to recommend its indiscriminate adoption. But he does not explain what that danger is. The Superintendent of Dehra Doon strongly advocates the plan of putting strychnine in the carcases of animals killed and left by tigers before they come back to eat them.

The Lieutenant-Governor of the Punjab agrees with the conclusion arrived at by a majority of local officers, that the existing system of rewards is sufficient, and no change is desirable.

Capt. Rogers' plan is generally pronounced to be unsuitable to the Punjab. The Lieutenant-Governor remarks that it is a known and undisputable fact that the number of wild animals is rapidly decreasing in the Punjab, and that if their destruction proceeds at the same rate as at present, the more dangerous animals will at no distant date be altogether exterminated. The chief cause of this diminution, he thinks, is the rapid increase of the population, and the immense extension of cultivation in the province, which has reclaimed vast tracts formerly covered with jungle, and affording shelter to wild beasts.

In the Central Provinces also, the destruction of animals dangerous to crops is left to the people themselves, the measures of Government being confined to those that are dangerous to human life.

The Oude and British Burmah authorities also support the existing system of offering rewards, and do not consider any other measures requisite.

The Resident at Hyderabad approves the existing system of offering rewards, and does not consider any change necessary. The Deputy-Commissioner of Booldannah says that, in the last few years, the wild animals are becoming much fewer in number, and that such an animal as a tiger will, before long, not be heard of in that district; he thinks Captain Rogers' plan to be a "dangerous one, and more likely to lead to the death of cattle and human beings than of tigers." The officers consulted by the Chief Commissioner of Coorg are of opinion that the continued payment of rewards, at an increased scale, will effect the gradual extirpation of the most dangerous and destructive class of wild beasts. The Chief Commissioner concurs in this view, but says that "in certain localities, so as to effect the destruction of particular animals, some of Captain Rogers' suggestions might be adopted with advantage." He, however, does not specify the suggestions.

The following extract from the proceedings of the Bombay Government* connected with a recent case of fraud, will show to what extent funds assigned by Government for the destruction of noxious animals are capable of being misappropriated under the new system:—

"A most impudent fraud has been practised. It appears that the average annual payments for the destruction of wolves in the Seerpore Talook of Khandeish was 390 Rs.; whereas from the 31st March to the 21st May, 1859, no less a sum than 3,381 Rs. was paid on this account. Of this sum 581 Rs. was disbursed by order of the Mamlutdar between the 31st March and 23rd April. On the latter date the Mamlutdar went on leave, and the Head Karcoon took charge. Between then and 21st May he managed to pay away 2,800 Rs. The fraud was then discovered."

The following extract from the report of the collector and magistrate shows the bare-faced manner in which this system of robbery was carried on:—"There is reason to believe that no trouble was taken to procure even a few wolf skins to give colour to the fraud; for of the 45 skins which were seized when the fraud was discovered, and for which an order had actually been written on the treasury to pay the rewards, there is not a single wolf skin. They consist of village cat skins, fox skins, jackal skins; and it is probable that the whole of the rewards were paid on this lot of skins brought up over and over again, some of them having been torn across and sewn up again."

The rules for payment of rewards require that the skins should be accompanied by a report from the village officers, stating that the bearer had killed the animals in question and was entitled to the reward. An examination of the skins has also to be made by a "punchayet," or jury. These rules were duly observed, but false reports were received from the villages, and any person who happened to be present in the kutchery was made to go through the form of signing the report of the jury.

The following resolution was recorded:—The papers now before the Government of India conclusively establish the fact that the evil under consideration is a very serious one. The loss of life, though probably not quite accurately reported, is certainly enormous. Nowhere is the destruction of life by wild beasts so great as in the lower provinces of Bengal. In other provinces, as cultivation and civilisation have advanced, wild beasts have diminished in number. In the Punjab, and in most parts of the Bombay Presidency, the presence of the more dangerous species is now stated to have become exceedingly rare.

In the opinion of the Governor-General in Council, this serious mortality could be very largely reduced by the extirpation of those animals in the neighbourhood of human habitations. This should be first attempted, and every reasonable means taken to secure their destruction whenever they make their appearance near towns or villages. The system of rewards hitherto in force in all provinces seems to be the most effective means by which the Government can accelerate the work, and local governments and administrations are empowered to increase, within the limits of their respective budget allotments, the rate of the authorised rewards whenever such a measure is considered desirable; but rewards should only be given for killing destructive, and not merely wild, animals.

As regards snakes, it seems to be overlooked by many officers that there is a deep-rooted prejudice among most natives against killing a snake—a prejudice which nothing but the offer of a reward will overcome. And, as deaths from

* Revenue proceedings for October, 1870.

snake-bite are extremely numerous, the Governor-General in Council has no doubt that the recent prohibition against the grant of rewards for killing snakes should be partially withdrawn, and that rewards not exceeding two annas a head, as a general rule, should, at the discretion of the local governments and administrations, be offered for snakes known to be deadly, that is, the cobra and some other species to be expressly named. But such rewards should not be offered throughout a whole province or for an unlimited period, but in selected districts, where the mortality from snake-bite is greatest, and for a period not exceeding two years. At the end of this period the result of the experiment should be reported to the Government of India in order that, if successful, the propriety of extending it may be considered; and it is clear, from the correspondence, that care should be taken that no reward be given without the snake, when killed, being seen by the officer who grants the reward, and that the head of every such snake be cut off and destroyed as soon as the reward is given.

In 1871-2 the Government of India, at my request, caused me to be furnished with the returns of death by snake-bite in the following provinces for 1868. It appears that there were in Bengal 6,219 deaths; Orissa, 350; Assam, 76; North-West Provinces, 1,995; Punjab, 755; Oude, 1,505; Central Provinces, 606; Central India, 90; total, 11,290.

This portion of India is not much more than half the whole area, and the returns are but very imperfect, as up to that time no very reliable records were available. Thus it is probable that if Bengal had a mortality of 6,219, Orissa and Assam together, both regions prolific in poisonous snakes, would probably give a larger return, if accurate records were kept, than a total of 420 deaths from snake-bite. The most obvious mode of dealing with this national evil is prevention, and the adoption of a rational mode of treatment, and though comparatively little may be expected from the latter, much may be anticipated from the former, and it is to be effected by making the nature and appearance of the known venomous as distinguished from the innocent snakes, and by offering rewards for their destruction, to be judiciously distributed. Such was the object of the work that I wrote and presented as a parting gift to the country, when I left it in 1872, and when I stated that the real mortality from the snake-bite for the whole of India was probably in excess of 20,000 annually. I think you will allow there were good grounds for the assertion.

The snakes that are so destructive to life in India are the cobra, the bungarus or krait, the echis, and the daboia, or Russell's viper, all most conspicuous snakes, and easily identified. There are others, but they are comparatively rare, and seldom bite men. In the book referred to there is a picture from nature of each venomous snake known in India, so that there can be no possible difficulty in recognising them.

This book is, or should be, distributed over India for the purpose I have described, and it is about to be supplemented by a smaller edition by Dr. Ewart, which will place full information within the reach of everyone, so that no excuse can exist for difficulty in distinguishing venomous from harmless snakes. Rewards should be offered for venomous snakes only. This, if steadily carried out, and the money paid by some responsible official on identification, would soon diminish the number of snakes and deaths from snake bites. And I must earnestly protest against the validity of an opinion expressed by some authorities in India that such rewards are useless;—useless they may have been when distributed without discretion for snakes not poisonous. If this method of dealing with the subject, and who can deny its importance, be adopted—but it must be done willingly, and not with a foregone conclusion that it will fail—I am certain that, as part of a comprehensive scheme for the destruction of noxious animals generally, it will succeed.

The Bombay Government, in a resolution of the 17th June, 1872, for example says:—"The experience of the last 15 years on the subject of rewards for killing snakes, shows that at present no effectual antidote to the poison of the snake is known.

"That in districts where the work of snake killing has been actively carried on, the death-rate from snake bites has been gradually reduced. That in Rutuaghery, where more has been done in the matter than in any other part of the Presidency, the death-rate has been reduced from 257 in 1856, to 37 in 1869; while in Kaira, where the reward offered has not as yet been enough to overcome the dislike of the people to kill snakes, the death-rate has risen from 46 in 1856, to 72 in 1869."

The Government of India, addressing the Secretary of State on this subject, on 27th November, 1874, says:—"The reports furnished by the local governments and administrations, show the measures that have been taken under resolution of 11th September, 1871, and the result of them. There is no doubt that a great deal has already been done towards the extermination of wild beasts, and as the subject is engaging the earnest attention of the local authorities throughout India, it is hoped that future results will be more satisfactory as regards snakes, but Government is of opinion that the experimental offer of a reward for their destruction has been a failure. As the arrangements for the destruction of wild animals now in force seem likely to prove sufficient for the purpose in view, Government is not disposed to sanction Captain Rogers' proposals, which do not commend themselves to its judgment."

To recur to the feline animals, I have taken the following from the Madras Reports.

The destruction of wild beasts was vigorously prosecuted, and with greater success in 1873 than in 1872.

In the northern and western ranges it appears that in those two years 391 tigers were killed, whereas in the years 1866 to 1869, an average of 186 tigers was killed in those districts.

Special rewards were given in Kurnool and other districts—58½ Rs. in 1871-72, and 49 Rs. in 1872-73, for each tiger.

Cheetahs (*Leopards*).—In 1871-72, in certain districts in the Madras Presidency, 678 were killed; in 1872-73, 788. In the three years from 1866 to 1869, 898 leopards (or panthers) were killed yearly on the average. The average reward was

13 and 14 Rs., but in Canara, a special reward of 40 to 44 Rs. was given.

Bears.—In 1871-72, 102; in 1872-73, 115 were killed, more than half of them being killed in Ganjam; 5 Rs. 11 annas was the average reward paid.

Hyænas.—In the two years 1871-72, 1872-73, 203 were killed in Ganjam, Vizgapatam, Kishai and Kurruck, and 17 other districts; $3\frac{1}{4}$ Rs. was the annual reward paid for them. Wolves are not numerous in Madras; 14 were killed in 71-72; 20 in 72-73; 5 Rs. were paid for each.

In Malabar in 1873, 9,300 rupees were paid for alligators. The grant of rewards for these Saurians has been discontinued, excepting in rare cases, where a large one proves dangerous.

"On the whole," says the proceedings, "the grant of rewards, amounting to 24,000 rupees yearly, represent the destruction of nearly 1,200 dangerous animals, a result which the Board regards as satisfactory. The Board now recommends that the maximum reward for a full grown tiger be 50 rupees, for a leopard 25 rupees, and it appears that the Madras Government sanctioned 100 rupees for every tiger killed in the district of Ganjam, Jeypore, Godavery, Kurnool, South Canara, and Coimbatore.

In August, 1873, the Madras Government appointed Captain Caulfield to the temporary duty of destroying tigers in the Coimbatore district, until 31st December, 1873. Inspector Mackenzie, of the police, was appointed to act under Captain Caulfield, and the collector of Coimbatore was directed to ensure every assistance to Captain Caulfield. Elephants were also placed at his disposal; he was to report to the Inspector-General of Police, who was also to collect materials from all the districts in the Presidency, so as to enable the Government to form an opinion of the requirements of other parts of the country in this matter, and into the extent and direction in which the police may be more especially employed in shooting and poisoning tigers.

The magistrate of Coimbatore, in a letter regarding a plan proposed by Dr. Shortt for poisoning tigers by strychnine, says:—"It appears to me that the offer of rewards has been singularly futile. For two years the 100 rupees for every tiger in the Saltiamunganum hills, and the 300 rupees, and finally 500 rupees, for a known man-eater were offered; and though several attempts were made, the man-eater was not shot, but finally poisoned. I beg leave, therefore, to withdraw the rewards, and to substitute a special report in each case where an extra reward seems to be called for." He suggests that the magistrate of a district should be authorised to expend a certain amount, say 500 Rs. annually, in destroying noxious animals. Dr. Shortt's suggestions were to be tried; but no very definite results were obtained.

It appears that, among other measures, Capt. Caulfield tried traps for the destruction of tigers and leopards, and they were found, to a certain extent, successful. The Inspector-General of Police, on the 17th Nov., 1873, says, in a letter to Government, *inter alia*:—"I enclose reports for the magistrate of Vizagapatam, showing that there has been fearful loss of life on the Narayanapatam pass into Jeypore. There is every reason to believe that the destruction of cattle by tigers throughout the Presidency is enormous."

Capt. Caulfield's bag up to that date was as follows:—Seven tigers, of which three were man-eaters. Two panthers, of which one was supposed to be a man-eater. Only one tiger was shot, three were poisoned, five trapped. Strychnine was placed in the carcases of nine bullocks killed by tigers. In two cases the tigers did not return, and only in one instance have the bodies of two tigers poisoned been found.

The people are everywhere encouraged to shoot wild beasts. Under recent orders village heads can be supplied with poison, and with a further general introduction of these traps where needed, I have little doubt of a satisfactory result ultimately.

In another letter, 16th January, 1874, the magistrate says:—"Traps do not seem to have been so successful, as only two tigers were destroyed, and one escaped. They are generally too wary to be caught in traps to any extent. The loss of life has diminished since 1872, when 29 lives were debitable to one tiger."

The means sanctioned by Government, and now in full operation, seem likely to check the career of cattle-killing tigers, and prevent their further mischief. Capt. Caulfield's operations extended to Vizagapatam and other districts, and with considerable success. The Government, in their orders in the Inspector-General of Police's letter, of 6th April, says, *inter alia*:—"The Government concur with the Inspector-General, that the most effective way of dealing with the evil is to offer handsome rewards for the destruction of these animals. The ordinary reward, by the standing order, is 35 Rs.; but, as far back as 1865, magistrates were authorised to offer, without reference to Government, such rewards, for any tiger which has destroyed a human being, as they may deem sufficient, not exceeding 100 Rs. Subsequently, in the same year, 100 Rs. were sanctioned for every tiger killed in the Vizagapatam Agency. The Government now resolve to extend this last-mentioned order to the five districts now shown to be so notorious for tigers, and to Coimbatore. His Excellency in Council will be prepared to enhance the reward on due cause shown, as was done for a period of five years in a portion of the Kurnool district with such excellent results, no less than 67 tigers having been destroyed under the stimulus of the offer of 300 Rs. a head." And it is added "that the basis of the recommendation for a permanent reward of 100 Rs. was, that the superstitious of the people led to a considerable outlay in the slaughter of a tiger. They reverence it as they reverence every other object of fear, and he who kills a tiger incurs great expenditure in cleansing himself from the crime!" The Government further says, "Every opportunity should be taken of teaching superintendents of police how to construct and set Capt. Caulfield's trap, and the Inspector-General should procure and distribute doses of strychnine to the infected districts."

Captain Caulfield's diary in July, 1874, gave some interesting but shocking details of the ravages of tigers in Naryanapatam. "This place lies in a valley surrounded on all sides by high hills covered with jungle. As near as possible 40 deaths (human) have occured here during the past

12 months. I am of opinion that two tigers are at work. In three cases the villagers turned out at once, in each case the tiger killed several men within 12 hours. There appear to be very few cattle killed. I am, therefore, led to believe that the tiger or tigers live habitually on human flesh.

Seventeen deaths have been reported since the 1st of November of last year; probably double this number would be nearer the correct thing. I have made out four deaths since our arrival here, which had not been reported."

Captain Caulfield says, "tigers which take to killing people, are notoriously cunning, and generally range over a beat of some 30 square miles. They have, in most cases, certain places which may be called their head-quarters.

With two or three Europeans systematically at work during the next cold season, I think the district might be cleared of man-eating tigers."

The Government again approve of Captain Caulfield's proceedings, sanction his requests, and empower the Medical Department to meet demands for drugs required in the fever districts in which the operations are carried on.

The system of poisoning by strychnine, though to a certain extent successful, was not altogether satisfactory, and aconite was suggested by the Surgeon-General, it being said to have succeeded in the Himalayas.

Captain Caulfield's appointment does not seem to have terminated on the 31st of December, 1873, as I find several reports from him in 1874, but I do not know exactly what he is doing now. It is not necessary to multiply details, the above is quite sufficient to show how the Indian Government have dealt with this great evil, and that they have evinced no want of appreciation of its magnitude and importance.

I have selected these details from the Madras reports because they forcibly illustrate what has been suffered, and what has been done in one part of India. But I find that in Bombay, Bengal, the North-West and Central Provinces, and Native States, the Government and political agents have all shown themselves alive to, and interested in, the subject, and all or nearly all have expressed their opinions, concurring that the evil is great, and needs remedy. A variety of rewards are offered in different localities, full price for adult animals, half or less for cubs. Some think that rewards should be continued; some that they should be given up, or only given in special cases; some, again, think the rewards too high, others too low. A variety of opinions as to the measures for their destruction exists, but all alike recognise the evil. This much is certain that the subject has attracted attention all over India, even in independent native States, and that the chiefs, notably those of Jeypore and the Nizam, have proclaimed rewards for the destruction of noxious animals. It cannot be said, therefore, that Government is indifferent or misinformed, or that it has omitted to consider the existence of the evil. What is wanted, in my opinion, is a system to be laid down on general principles for the entire country, and worked out in detail according to the needs or peculiarities of each district. There should, in short, be a department, or a branch of a department, with a responsible chief and subordinate agents, for whom certain rules should be laid down, to be carried out steadily and without hindrance throughout the country, leaving much as to detail to the discretion of local authorities. I would insist on the importance of carrying it out on broad principles everywhere. When such orders are made imperative, and when a department is got into working order, then, I believe, noxious animals will decrease and prosperity will increase.

It is not necessary here to go into details, ample means exist, if sought, for such a scheme in India, and if the matter were entrusted to an officer, such as he who controls the Thuggie and Dacoitee departments, we may feel certain that the result would be as good (in a few years) in the case of noxious animals as it has been in that of noxious men, Thugs and Dacoits.

The *Gazette of India*, of 31st March, 1877, in alluding to the net results of the measures now in force in the different provinces towards exterminating wild animals and venomous snakes in the year 1875, tells us that upwards of 21,000 persons and 48,000 head of catttle were destroyed by wild animals and venomous snakes during the year, that 22,357 wild animals and 270,185 venomous snakes have been killed, and that 1,20,016 Rs. have been expended in rewards, and remarks that these figures deserve the careful consideration of local governments and administrations, in view to such measures being adopted in each province as seems best calculated to diminish this loss of life and property.

Endeavour to estimate the value of life and property destroyed, a very rough calculation will give some idea how great it is.

The value of 48,000 head of cattle, however, is not the money worth alone, but represents that of food lost and tillage prevented, and who can estimate the money value—albeit life has never been set very high in India—of 21,000 human beings so lost? But one may imagine the desolation and horror of the survivors, the depressing and deteriorating effect it must have on cultivation and development of industrial energies of the villages and communities exposed to such losses, and how it must paralyse all efforts towards progress, comfort, and prosperity. Such results, indeed, are graphically illustrated in some of the reports I have read to you. And can nothing more be done to mitigate this evil?

From what I have already said, you see that a scale of rewards has, at various times, been offered for the destruction of wild animals, differing in different localities, and varying according to the urgency of particular cases, that the people have been encouraged also to rid themselves of their enemies, and that special arrangements, in some cases, have been made for assisting them to do so.

The following is a scale of the rewards offered in different parts of India, at different times, for wild beasts and snakes:—

Tigers.

	Rupees.
Bengal	$12\frac{1}{2}$ to 50
Berar	10 — 20
Bombay	6 — 60
Burmah	5 — 20
Central Provinces	10 — 100
Hyderabad	20
Madras	50 — 500

	Rupees.
Mysore	35
North-West Provinces	10
Oude	none
Punjab	none
Rajpootana	10 — 15

Lions.—The only record of which I find official mention is 25 rupees in Kotah.

Panthers, Leopards, Cheetahs.

	Rupees.
Bengal	2½ to 10
Bombay	3 — 12
Burmah	5 — 10
Hyderabad	10
Madras	25
Mysore	15
North-West Provinces	5
Rajpootana	8 — 10
Central Provinces	5 — 12

Wolves.

	Rupees.
Bengal	5 to 20
Berar	3 — 5
Bombay	4
Central Provinces	2 — 5
Madras	5
North-West Provinces	5
Oude	1 — 6
Rajpootana	5

Hyænas.

	Rupees.
Bengal	1 to 2
Berar	5
Central Provinces	½ — 2
Madras	3¼

Bears.

	Rupees.
Bengal	1¼ to 2½
Berar	5
Bombay	3 — 12
Burmah	5 — 12
Hyderabad	5
Madras	5
Central Provinces	2 — 5
North-West Provinces	3
Rajpootana	5

Snakes.—(Species not reported).

Bengal	4 annas.
Berar	
Bombay	6 pie to 4 annas.
Burmah	
Central Provinces	1 rupee.
Hyderabad	2 rupees to 8 annas.
Madras	1 anna.
Mysore	8 annas.
North-West Provinces	2 rupees.
Oude	
Punjab	2 annas.
Rajpootana	1 to 8 annas.

No reward appears officially proclaimed for elephants, buffaloes, or bisons. In cases of notorious rogues, rewards have been specially given. In Burmah, 5 to 20 rupees offered for alligators; in special cases, more have been given in Bengal and Madras.

The difference in the amount of the rewards appear to indicate that the higher sums were offered in special cases, probably where the creature was a notorious man or cattle-slayer.

Now, I cannot help thinking that if local governments made it part of the duty of district officers, not merely to proclaim these rewards, but to encourage the destruction of wild animals and snakes, by the operation of an organised establishment, with which they should be supplied in these districts, much benefit would result. The money rewards already offered would probably suffice for wild animals, but those for venomous snakes should be increased; and if the people were encouraged to work for them, and were aided by persons acting under properly selected superiors, the result would soon be a diminution of the wild animals and snakes. But I repeat that until some organised establishment is formed, to be worked steadily throughout the whole country—not dependent on the will or subject to the caprice of individuals, but under local officers subject to one head—no real or continuously progressive amelioration of the evil can be anticipated. Such a department working under a selected officer would, as in the case of Thugs and Dacoits, soon make an impression on what, so long as it continues in its present condition, must be regarded as a defect in our administration.

Supplement to the Paper on Destruction of Life by Wild Animals and Snakes in India.

As most important, because most destructive, I shall begin with the feline race, taking them rather in order of destructiveness than of zoological classification. First in size, strength, and ferocity is the tiger (*Felis tigris*). I will describe briefly a few points in his structure that fit him for his predatory life, and that apply to the *Felidæ* generally. The *Felidæ* are distinguished by a rounded head, short but powerful jaws, formidable fangs, and cutting teeth. They have vigorous limbs, digitigrade feet armed with sharp retractile claws, and cushioned with soft pads, which give the noiseless, stealthy tread, and vigorous spring. Active by night and day, vision is adapted for either; the pupil dilates widely in a feeble, while it contracts to a slit or point in bright, light. Hearing is acute; speed, strength, and agility great. The tongue is covered with sharp papillæ, which give it a rasp-like appearance, and by which the remaining flesh, that has escaped the teeth, is licked from the bones of its prey.

The *Felidæ* are distributed widely over the globe except in Australia; but the tiger is limited entirely to Asia. The general appearance of this animal is so familiar that it seems superfluous to describe it. Its figure denotes a combination of great strength and agility, the elongated compressed body, the vigorous limbs, with elastic cushioned digitigrade feet, sharp retractile claws, powerful muscles of jaw, neck, forearm, and shoulder, and formidable fangs, proclaim a creature armed and fitted to wage war against all other animals.

The skull of a tiger is adapted for the insertion and action of powerful muscles and teeth. The tentorium, or septum, that separates the cerebrum from the cerebellum, and which in man and many other creatures is membranous, is bony in the *Felidæ*, probably for the purpose of increasing the strength of the skull, and not, as has been suggested, for that of diminishing the shock of cerebrum against cerebellum in their leaps and bounds, for which purpose, indeed, the elastic membranous tentorium would answer better. The lower jaw is short and strong, articulated to the

skull by a hinge-like joint, which restricts its movements nearly in a vertical plane. The coronoid process, which gives insertion to the temporal muscles, is proportionately large. The muscles are very powerful, and arise from large and deep fossæ, which have well-marked ridges of bone. The zygomas form expanded arches, and give attachment to certain bundles of muscular fibres. The masseter muscles, which move the lower jaw, are large. The teeth are firmly implanted in deep sockets, and have special forms entirely adapted for flesh eating. In each jaw there are six incisors, the outermost resembling small canine teeth, and two long and powerful canine teeth, or laniaries; these are the formidable fangs, and are pointed, recurved, convex, groved in front and sharp-edged behind. The lower canines are rather smaller than, and pass in front of, the upper when the mouth is closed. The molars are eight in the upper jaw, the first being only rudimentary, and has no corresponding tooth in the lower jaw. There are six in the lower jaw. The second tooth in both upper and lower jaw has a conical crown and two roots. The third upper tooth has a cutting crown, with three pointed lobes, and a flat inner side against which the cutting teeth in the lower jaw work obliquely. There is a small tubercular tooth behind and on the inner side of the upper tooth. These tuberculated cutting teeth are called sectorial, "dents carnassières" of Cuvier. The formula is, incisors, $\frac{3 \cdot 3}{3 \cdot 3}$; canines, $\frac{1 \cdot 1}{1 \cdot 1}$; premolars, $\frac{3 \cdot 3}{2 \cdot 2}$; molars, $\frac{1 \cdot 1}{1 \cdot 1} = 30$. The small incisors are used to gnaw the soft ends of bones and to scrape off fibrous and tendinous structures. The long fang-like canines seize, pierce, and hold the prey. The sectorial, or scissor-like teeth, cut and divide the flesh or crush the bones. The special senses of hearing and vision are acute, whilst scent seems to be defective. The pupils are round, in which respect they differ from some other cats, which have them vertical; the tapetum lucidum is of a greenish hue, which gives the eye a peculiar and characteristic glare when the pupil is dilated, and is often well seen in the wounded tiger when crouching preparatory to a charge. The tactile sensibility is acute, especially in the so-called whiskers upon the chin, lips, cheeks, and eyebrows. Each hair has extreme sensibility at its root, and is movable by muscular fibres which surround the hair bulb, which is connected with a bed of glands and with the nerves of the lips. They are of use as feelers in their stealthy movements by night and day. It is not only in the jaws that the muscular development is so remarkable, but also in the neck, shoulder, and forearm, in the anterior as contrasted with the hinder extremities. The tiger can not only strike down a cow or even a buffalo with his forearm and paw, and hold it with the long fangs, but can raise it from the ground through the action of the powerful muscles of the neck, and carry or drag it to his lair, where it is devoured at leisure. The claws are remarkable; there are five in each fore and four in each hind foot. The mechanism by which they are made retractile is interesting; the claw and the phalanx into which it is fitted are kept in the retracted position by an elastic ligament which connects the two phalanges. It is unsheathed by the action of a flexor muscle (*flexor profundus*) which opposes the action of the ligament. The claw phalanx, when retracted by the ligament, is drawn to the outer side of the second phalanx, not on to it; the joint that connects them being so formed as to admit of this oblique action. By this arrangement the claws, during ordinary progression, are kept out of the way, and are consequently not liable to wear or be blunted by contact with the ground.

There is only one species of tiger, though there are several varieties in colour, and even shape. The colour is exceedingly beautiful. The ground is of a rufous, or tawny yellow, shaded into white on the vertical surface; this is varied by vertical black stripes, ovals, or brindlings. On the face and back of the ears the white markings are very conspicuous. The depth of colour varies according to the age and condition of the animal; the young are more dusky in the ground colouring than the old. It is also affected by locality and climate; forest tigers are of a deeper shade than those of more open localities. It is remarkable how well the colour harmonises with the cover among which the tiger prowls.

The tigress is smaller than the tiger. The head, neck, and body are finer and lighter. There is no crest. She is more active, and, when with her young, more savage and aggressive than the male.

The tiger has many native synonyms, according to his *habitat*. In Bengal he is Bagh, F. Baghni, Sita-bagh, Go-bagh. In the north, Sher; female, Sherni. In Central India, Nahar. By the Santhals, Tut, Puhug. In Goruckpore, Nungya-chor. In Tamul and Telagoo he is Puli, Pedda-puli. In Malabar, Parampuli. In Canarese, Huli. In Tibet, Tagh, Lepcha, Sahtong. In Bhootan, Tukh. In Chinese, Lau-chu, or Lau-hu.

The tiger was known to the ancients. He is the *τίγρις* of Greek, the *tigris* of Latin, authors. He figured in the Colosseum, and other amphitheatres. Pliny says:—"The tiger is produced in Hyrcania and India." Augustus was the first who showed a tigress in Rome. At the dedication of the theatre of Marcellus, the Emperor Claudius exhibited four tigers; and Suetonius speaks of tigers exhibited by Augustus. It was said by Dion, that the tigers first seen by the Romans and Greeks were sent by the Indians when they were sueing for peace from Augustus. The Emperor Philip on one occasion exhibited ten tigers, along with lions, elephants, and other wild beasts. Gordian, Antoninus, Eligabalus, and Aurelian also exhibited tigers in the circus and in triumphal processions. Greek and Latin authors make frequent allusions to the tiger.

Mosaics found in Rome show the tiger devouring his prey. Those exhibited by the Romans were probably brought from the Elburz mountains, south of the Caspian—the ancient Hyrcania—and from India. In these countries they still exist, though seldom seen west of the Indus.

The geographical distribution of the tiger is very wide. Buffon said it was found in South Africa as well as Asia, but he was wrong; it is confined entirely to Asia, though over a wide area—from Ararat and Caucasus west, to the frozen island of Saghalien east (but not on the high table-land of Thibet); from Cape Comorin to the Himalayas, to the height of 6,000 to 8,000 feet. One was killed in 1874 at Dalhousie, 8,000 feet above the sea. It is found in Georgia, north of

the Hindoo Kush, Bokhara, Persia, south of the Caspian (Hyrcania), on the shores of the Aral Blyth says it troubled the Russian surveyors, during mid-winter! as far north as the shores of the Obi; and in the deserts which separate China from Siberia; on the Irtisch, and in the Altai regions. In Amur land it is said to be very destructive to cattle. In China, Siam, Burma, and the Malayan peninsula, Singapore, Java, Sumatra, and perhaps other islands, but not in Borneo or Ceylon. It is a mistake to call the tiger only a tropical animal, though, no doubt, the finest specimens are tropical, being those of Bengal.

The tiger is found in many of the tree and grass jungles throughout India: those remote from population and cultivation are most frequented; but, when compelled by hunger, he visits the cleared and cultivated localities, and becomes the dread and pest of the villagers, who are in constant dread for their own or their cattle's lives, though certainly the cattle are most endangered. During the cold and wet season he is restless, and wanders about from place to place, and has no fixed abode, though he keeps within a certain range of country. When the cover is thick, he roams in search of food, and during these seasons is safer from his human foes than in the months of March, April, and May, which, in many parts of India, is the tiger-hunting season. The grass and jungle of the cover at this time having been burnt, the shelter become less extensive. The heat is intense, and the tiger seeks the patches of rank grass and swamps, which are cool and moist, where, as also in the margins of the forest, he lies at rest during the heat of the day, sheltered from the sun's rays. Such retreats are often near villages and cattle grazing stations, and here tigers live, and feed on the cattle; taking a cow perhaps every second or third day. In some cases they take to man-eating, and, when they do, soon depopulate a village by killing some and frightening away the others. In some parts of India it would appear that the man-eater is the rule rather than the exception. Jerdon says that in Central India, in the Mundlah district, near Jubulpore, in 1858 and previous years, an average of between 200 and 300 villagers were killed yearly by tigers. It is said that when a tiger has once killed a man, and tasted human flesh, he prefers it to other food. Whether this be true I cannot say, but there is no doubt that when he has overcome the natural dread of the human form, the man-eating tiger becomes the dread of a whole district. But it is remarkable with what indifference at other times they are regarded by the villagers, who carry on their usual avocations as herdsmen and wood and grass-cutters close to the cover in which the tiger is known to be concealed. This may arise from an apathetic and fatalistic disposition, or from the experience which teaches that, as a general rule, the tiger will not molest man when he is well supplied with other food. But it is certain that over many roads, and along many paths through the forest or grass, men will not pass day or night without tomtoms or torches to scare away the lurking enemy. It sometimes happens that a road is closed for weeks by a single tiger, and is not passable until he has been shot. Not only post-runners and herdsmen, but even those travelling in bullock carts are attacked and carried off; and yet it is strange to see the indifference with which his presence is often treated; the beaters will follow readily on foot, and beat him out of the jungle, though, should he pass near one of them, he is pretty certain to strike him down and inflict a dangerous, perhaps a mortal wound, though he is much less likely to do this if he is unwounded.

The natives of India, especially the Hindoos, hold the tiger, as they do the cobra, in superstitious reverence; many would not kill him, even if they could, for they fear that he would haunt or do them mischief after death. Some they regard as the abode of a spirit which possesses unlimited powers of mischief. In many districts the peasants are loth to pronounce his proper name, calling him the Gidhur (jackal), Janwar (the beast), or they refuse to name him at all; they do the same in the case of the wolf. But though they will not always do so themselves, they are willing that others should take his life, and they will not only point out his abode, but rejoice over his death, as it relieves them from destruction of property, and fear of their own lives. The remarks of these villagers round a fallen tiger are often very amusing and quaint.

All sorts of powers are ascribed to portions of the tiger after death. The fangs, the claws, the whiskers, are potent charms, medicine, love philtres, or prophylactics against the evil eye, disease, death, magic. The fat is in great demand, having many potent virtues in relieving rheumatism and other ailments. The heart and flesh are eaten as tonic and invigorating remedies giving strength and courage. The whiskers, among other wonderful powers, possess those, it is said, of being a slow poison when given with food. This belief one may try in vain to oppose. The rudimentary clavicles are also much valued.

It is almost impossible to preserve the skin of a tiger with its whiskers and claws intact. They are so valuable that one cannot keep them. I have known them to be carried off, aye, even the fangs extracted from the skull at night, when the dead tiger was placed under the charge of a sentry.

There is a common delusion among natives that the tiger gets an extra lobe to his liver every year of his life.

There is a popular belief, not confined to the ignorant, that the wounds of the claws or fangs of a tiger are dangerous, from being of a poisonous nature. This is an error. It is certainly possible that the teeth and claws may occasionally be contaminated with septic matters from decomposing food, but this is probably rare, as he is very particular in keeping them clean. The real fact is, the wounds are dangerous because they are deep, punctured, and lacerated; otherwise they have no peculiarity, and not unfrequently heal rapidly, though they often suppurate, and may then induce blood poisoning. I have seen the severest injuries recovered from rapidly, others, again, have caused much suppuration and destruction of tissue and loss of life.

It is remarkable how many persons escape from the clutches of a tiger. It seldom kills outright, and rarely carries the human victim far from the spot where he was struck down, except, of course, in the case of confirmed man-eaters. There is a blow, a bite, generally in the shoulder, a shake or two; the victim is dropped or dragged for a short

distance and then left. Such injuries are frequently fatal, but by no means always so. I know several persons who have been thus seized, and have escaped with life, seldom though without a crippled limb. When a man is seized simply for food, he is carried off and eaten just as a deer would be.

It seems to be the impression that tigers have not diminished since 1857—*i.e.*, since the disarming act after the mutiny. In some places, no doubt, cultivation and population have pushed them back, but in others they are as numerous as ever. Many tigers are destroyed yearly, but the destruction of life and property caused by them goes on, though perhaps not to so great an extent as sometimes represented, when it is remembered that the population of India exceeds 250,000,000, the proportions of deaths is not relatively so very large, and would not contrast so very unfavourably with mortality from preventible causes at home.

Mr. J. Hogg, for example, says, on an average three persons are killed daily in this country by railway accidents, and eight are daily injured. The year 1874 was memorable on this account, 1,421 persons were killed and 5,041 were injured. One in every 35 of the railway servants is killed outright yearly and many are injured.

There are several ways of compassing the tiger's death. They are secured in pitfalls and traps, shot by spring guns and arrows; poisoned by strychnine, and sometimes, it is said, taken by birdlime, which is spread on leaves; these adhere to the tiger's face, cover his eyes and blind him, when he is destroyed by spears; numbers are also shot by sportsmen or professional shikarries, either on foot, from elephants, or from machauns, but still the numbers keep much as they were, and probably will do so, until some better organised plans are devised for their destruction.

The late Captain B. Rogers, of the Bengal Army, in a paper read before the Social Science Association a few years ago, gave some curious information regarding the destruction caused by tigers in India. He devised a scheme for their destruction by traps and spring guns, but it was not accepted. He was an enthusiast, but there is no doubt that much of what he said was literally true, for example:—

Speaking of the destruction of life by wild animals, Captain Rogers says, in Lower Bengal alone, in a period of six years ending in 1866, 13,400 human beings were killed by wild animals, whilst 18,196 wild animals were killed in the same period at a cost of 65,000 Rs.; and it appears, moreover, that the Government reports show that in these six years ending in 1866, 4,218 persons were killed by tigers, 1,407 by leopards, 4,287 by wolves, and the remainder by other animals; the tiger and wolf thus claiming nearly equal shares. The worst district in Bengal Proper is that of Rungpore, in the Rajshahye Division, the yearly loss of life being between 55 and 60 persons. In Bengal Proper alone about 1,200 tigers are killed annually; of these 4 per cent. are cubs. Next to Bengal come the Central Provinces, and then certain parts of Madras.

The Chief Commissioner's reports of the Central Provinces show that in 1866-67, 372; in 1867-68, 289; in 1868-69, 285 persons were killed by tigers.

The District magistrate from Dhera Dhoon writes:—"Man-eating tigers are quite an exception in Oude and Rohilcund; one is heard of in every six years, but he is invariably killed after a short lapse of time." Captain Rogers says, however, that tigers are man-eaters by nature and instinct, not by education; "men, therefore, are liable to be eaten where tigers exist."

One gentleman, writing from Nayadunka in July, 1869, says:—"Cattle killed in my district are numberless. As regards human beings, one tiger in 1867-68-69 killed respectively 27, 34, 47 people. I have known it attack a party, and kill four or five at a time. Once it killed a father, mother, and three children; and the week before it was shot it killed seven people. It wandered over a tract of twenty miles, never remaining in the same spot two consecutive days, and at last was destroyed by a bullet from a spring gun when returning to feed at the body of one of its victims—a woman.

"At Nynee Tal in Kumaon, 1856-57-58, there was a tiger that prowled about within a circle say of twenty miles, and it killed on an average about eighty men per annum. The haunts were well known at all seasons. * * * * This tiger was afterwards shot while devouring the body of an aged person it had killed."

Captain R. relates an incident which illustrates the superstition of the native in regard to tigers:—"A tiger in Chota Nagpore destroyed a great number of lives. * * * * I had a weapon set across its known path, and it was only a matter of hours before his career was stopped. But what was the result? Numbers of the natives in the vicinity, including those I had employed to set the trap, ran off when they heard of the animal's death, and did not return for days, as they felt sure that when dead it would be revenged on them, and take the form of a human corpse so as to get them hanged for murder. The remains were not, on that account, shown to me until decomposed." Further, he remarks:—"When a Ghônd or Kurkoo (the people inhabiting certain wild tracts) is killed by a tiger, the wife, children, and parents are thrown out of caste—all intercourse between them and other inhabitants being interdicted, on the ground that they are labouring under the displeasure of the Deity. In fact, the man-eating tiger is the deity to whom those wild and ignorant aborigines offer prescribed sacrifices on the occasion of their having suffered from its ravages; thus the injury they have incurred is increased, and the previously scanty means of these helpless creatures are doubly taxed."

Again, quoting a Government report:—"In one instance, in the Central Provinces, a single tigress caused the desertion of thirteen villages, and two hundred and fifty square miles of country were thrown out of cultivation. This state of things would undoubtedly have continued, but for the timely arrival of a gentleman who happily was fortunate enough, with the aid of his gun, to put an end to her eventful career."

In 1868, the magistrate of Godavery reported "that part of the country was overrun with tigers, every village having suffered from the ravages of man-eaters. No road was safe, and a few days before his arrival at Kondola, a tiger charged a large body of villagers within a few hundred yards of the civil station."

Again, it is reported that one tigress, in 1869, killed 127 people, and stopped a public road for many weeks, until she was finally killed by the opportune arrival of an English sportsman.

Other instances will be added, though the above are sufficient to prove how fierce and destructive tigers can be, not only to cattle and other lower animals, but to human beings.

The Lion (*Felis leo*), known to natives of India as Burra Shêr; Singha; Untiah Bagh, has a much more limited range in India than the tiger. It seems to belong now more to the African than the Asiatic fauna, and probably attains a greater size in Africa. It is of various tints of colour; in India it is of a pale tawny hue, wanting the dark rufous tinge, and has a comparatively scanty mane, which is not so dark in colour as that of the African variety, and has the median line of hair on the abdomen less developed. The physiognomy is also somewhat different; it is, however, merely a variety. Even in Asia three varieties have been described, the Bengal, the Guzerat, and the Babylonian. It is smaller and less powerful than the tiger, though its large head and voluminous mane give it a more imposing appearance. The lion is from 8 to 9 feet in length, from the nose to the end of the tail, which is tufted, and has a small terminal spine. Its dentition and general structure are like those of the tiger. It is comparatively small, and weak in the hinder extremities. Some of the male Indian lions are nearly devoid of mane; the female is always maneless. It differs in its habits from the tiger; is generally said to be bolder and of a nobler character, but this wants confirmation. Its range in India is now very limited, and it would appear to be gradually becoming extinct; for it is no longer found in localities where, 50 years ago, it was not uncommon. It has entirely disappeared from Bengal, the North-West Provinces, and some other parts of India, is still found in Cutch, Guzerat, Hurriana, Gwalior, Saugur, and Persia; but is not known in Afghanistan, and is only at all common in the two first-named districts. It is no longer a denizen of Southern Europe, though within historic times it was found in Greece. But, indeed, it is becoming rare everywhere out of Africa; it is destructive to life, like other *felidæ*, but seems to prefer donkeys to all other cattle, and occasionally kills human beings; its comparative rarity prevents it from occupying a high figure among the destroyers of life in India. It does not inhabit swamps and deep forests like the tiger; but keeps more in the open, in the scrubby jungle, in ravines, sandy desert places, and among low grassy or thorny jungle covers. It is hunted from elephants, and it will fight and charge like the tiger. The lion and the tiger occasionally meet, and have, it is said, fought over a stricken deer. The tiger would probably prove the victor in such a contest.

I have not been able to ascertain the number of men or animals destroyed by lions in India, nor of the number of lions themselves that have been killed in any year; but, no doubt it is comparatively small.

I find that in Kotah, Rajpootana, the sum of 25 Rs. has been offered for lions, but the returns do not give the results of this offer.

I have been told by officers of the Central India Horse, who used to kill a certain number of lions yearly, that they are becoming rarer every year. All seems to show that the animal is disappearing from India, as he has done from Greece.

The Leopard, or *Pard* (*Felis-pardus*).—It is considered by some naturalists, and by a great many sportsmen, that there are two varieties, the larger or panther, the smaller or leopard. Others assert that they are identical, and that any difference is due to individual peculiarity, age, food, or habitat. Blyth, for example, considers them identical.

The leopard is known in India as Tenduah, Honiga, Cheeta, Cheeta-bagh, Gool-bagha, and other local names. It is of a more or less rufous fawn colour of different shades, with beautiful black spots arranged in rosettes. The tail is marked with black rings; it varies from six to eight feet in length. Jerdon also describes two varieties, the larger or panther, the smaller or leopard; but the probability is that they are accidental or local varieties of the same species. A degree of modification of form, colour, and size seems to exist in all animals under differences of climate, food, place of abode, &c.

Temminck considered the panther and leopard quite distinct from each other, and he assigned to the leopard a longer tail, with 28 caudal vertebræ, whilst to the panther—the larger—he gave a shorter tail and only 22 caudal vertebræ.

The leopard is widely distributed over India, but does not extend into Asia so far north as the tiger. It is found all over India, the hills and plains, and also in Ceylon; it is also an inhabitant of Africa. The larger variety is most frequent in the plains, among low hills and ravines; it is very fierce and active, and has been known to kill a full-grown bull. The smaller kind frequents forests and higher hilly districts, where it is very destructive. There is also a black variety, and its spots can be seen in the bright light blacker than the dark groundwork of the skin. It is comparatively rare, but occurs occasionally from the Himalayas to Ceylon and Assam, and the Malay peninsula. Hodgson regards it as a distinct species. The leopard extends through Western Asia as far as the Caucasus, Afghanistan, and Malayan peninsula, and also in Africa. It is very dangerous and destructive to human beings and other creatures, and is especially fond of dogs, which it carries off whenever it can get the opportunity. In some of the hill stations it is difficult to keep a dog, and it is necessary to protect them by putting a spiked collar round the neck. It is very active, and readily climbs trees, and when wounded is very dangerous. The Government returns for 1875 show that during that year 182 persons, and 16,187 cattle were killed by leopards. It appears from the same returns that 3,572 leopards were destroyed at a cost of 35,757 Rs., an average of 10 Rs. for each leopard, whilst for 1,789 tigers killed, 41,312 Rs. were disbursed, or about 23 Rs. per head. There are other species of leopard, but they are not found in the parts referred to as the seat of loss of life.

The cheetah, or hunting leopard (*Felis jubata*), is a very different creature; it is taller, slighter, has longer and more delicate limbs, with only partially retractile claws. It is of a lighter colour, and is spotted, but the spots are not arranged in the rosette-like form of the leopard.

It is found in the plains of India, chiefly in the southern parts, and is caught and trained for hunting antelopes, and is a great favourite with the native princes. There is no reason, I believe, to think that it is destructive to human life, or even to cattle; its habits probably lead it to prey on deer and antelopes.

Felis uncia, or the snow leopard, found in the Himalayah and Tibet, is smaller than the common leopard, has longer hair, and is also marked with spots. It feeds chiefly on burhal, the wild sheep, and goats, but has never been known to attack men.

Felis macrocelis, diardi, the clouded leopard or tiger, found in the Nepal Terai, and in Sikhim up to 5,000 to 10,000 feet high in the Himalayahs. Its limbs are very bulky, and its paws and claws large *(unde nomen)*, length of body, 3½ ft.; tail, 3 ft. It is of an olive or dark clay brown colour, and has large clouded spots or patches over its body, some black hair on the head and neck; the claws and feet are very powerful. It is a forest leopard, and is destructive to hogs, sheep, goats, deer, and pigs, but does not appear to destroy men or large cattle. *Felis onca* (jaguar) is a very large and fierce leopard, but it is confined to South America. *Leopardus japonensis* (Gray), *Leopardus brachyurus* (Swinhoe), are other species found, according to Jerdon, in Formosa and Japan.

Canidæ (*Canis pallipes*).—The Indian wolf differs somewhat from the European species; it is of a hoary, grizzled, dirty reddish colour, some of the hairs being tipped with black; ears rather smaller than in the European species. It is known to natives of India as Bherya, Nekra, Hundar, and by other local names. It is very common in some parts of India, as in the North-West Provinces, Oude, Rohilkund, Rajpootana, and is very destructive to life. It takes children, frequently carrying them off at night from their huts, and it has been known to take them out of their mothers' arms. Wolves generally hunt in packs, and have been seen in the Southern Mahratta country to chase antelopes in this fashion. They are very wary, and pursue their prey with great stealth; some lying in wait, whilst others drive the animal in their direction. They are seldom seen in the daylight, hunting chiefly at night. Smaller than the European wolf, they are just as cruel and bloodthirsty. Living in holes and ravines, and of nocturnal habits, they are seldom met in the fields. Surprised by day, they strike off at a long loping gallop, in which it is almost impossible to overtake them; they are generally silent, but sometimes bark like a dog. The formidable teeth are arranged in this formula—

Incisors.		Canines.		Premolars.		F Molars.		Molars.
6	..	1 1	..	4 4	..	2 2	..	3 3
6	..	1 1	..	4 4	..	3 3	..	4 4

Very destructive to deer, sheep, goats, and other horned cattle, they seldom attack the larger ones unless feeble, as they often are in India, or adult human beings, but they do so sometimes, and then it is in concert. They bite the throat, and I have seen children who, having been rescued from their grip, were found to be mortally wounded in this way. There are other species, but they are comparatively rare and, are not found in the plains of India.

In 1875, 1,061 human beings, 9,407 cattle, sheep, and goats, were destroyed by wolves; whilst 5,683 wolves were killed at a cost of 15,186 Rs., or a little less than 3 Rs. a head.

The *Times*, of June, 21st, 1877, gives the following information about wolves in Europe:—European Russia, according to the official report, contains 200,000 wolves, and in 1875 they killed 161 persons; whereas in 1849, 1850-51, the average deaths were 125; 108,000 cattle and other live stock are annually destroyed, besides poultry and dogs; the former being the usual diet of young wolves. The total loss is estimated at 15,000,000 Rs. per annum, and the loss in Siberia mnst be very considerable, especially reindeer.

I find in *Allen's Indian Mail*, of 21st July, 1877:—

Wolves at Lucknow.—Wolves, it appears, are re-frequenting the neighbourhood of Wingfield-park. At dusk, on Tuesday evening, as a woman and a little boy were returning through a ravine from their field to their village they were attacked by two of these ferocious animals and literally torn to pieces. The Government reward offered for the destruction of these wolves is not sufficiently high to induce native shikarees to undertake the task.—*Lucknow Times.*

The natives of many parts of India have a most superstitious dread of the wolf; they will not only not destroy them, but they will not even mention their names, fearing that they will thereby bring down misfortune on themselves or their children, and it is consequently difficult to compass their destruction.

Canis aureus (the jackal), Gidhur in Hindostanee, is not generally destructive to human life, but I have known young children to be carried off by them, and also young or feeble animals, but they are essentially feeders on carrion. They are not named in the return of 1875 as among the destroyers of life, but no doubt they form an item in the heading "other animals," though it is not probable that they have sinned to any great extent.

Hyæninæ.—*H. striata* (the striped hyæna), Jhirak, Lakhar-bagh, Rera, and other local names.—This animal is of a grey colour with transverse tawny stripes. It has a mane on the neck and back. It is a treacherous, cowardly brute, common all over India, inhabiting holes and caverns, often prowls into villages, and is generally met with at night. Its jaws are very powerful, and the teeth most formidable; it can crush a large bone with ease. It destroys a certain number of animals, generally the young and weak, but it lives also on carrion. It takes dogs, sheep, poultry, or any animal it thinks itself bold enough or strong enough to overcome, but it will seldom attack a man or large animal unless it can do so quite unawares. It has an unearthly, disagreeable cry.

The hyæna has a most formidable set of teeth, the formula of which is:—

Incisors.		Canines.		Premolars.		Molars.
6	..	1 1	..	4 4	..	1 1
6	..	1 1	..	4 4	..	1 1

In 1875, 68 persons and 2,116 animals fell victims to hyænas, whilst 1,386 hyænas were killed, at a cost of 3,602 rupees, or less than an average of three rupees each.

Bears (*Ursidæ*). — The bears are mostly fru-

givérous, or root-eating animals, but at times some, perhaps all, are carnivorous. They are nocturnal in their habits, and some are very aggressive and fierce. I have related a well-authenticated case in which a bear entered a village, got into a house, and killed several people before it was destroyed. Many lives are lost by bears, but it is more probably from ferocity and an aggressive nature than from any desire to eat that which they have killed. They live in caverns, holes under rocks, hollow trees; climb trees for honey and fruit. Moreover, they are very fond of the flowers of the *Bassiâ latifolia* (mhowa-tree), and it is said they get much excited by eating them. Where the bear is common, especially the Himalayan bear, the villagers often suffer considerably; some are killed, others are severely mutilated, and are generally injured in the face.

There are several species:— *Ursus isabellinus*, the brown or cinnamon bear; a fine, large, and powerful bear of a yellowish brown colour, found in the north-west Himalayas and Kashmir; it does not appear to contribute much to the mortality, but *Ursus tibetanus*, the Himalayan black bear, found in the Himalayas and Assam, is often very fierce and aggressive. *Ursus labiatus*, or sloth bear, is found throughout India, from Cape Cormorin to the Himalayas; it is found chiefly in hilly and jungly districts; these are the bears that destroy most life.

The teeth and claws are formidable, and capable of inflicting severe wounds. The formula of dentition is:—

Incisors.		Canine.		Premolar.		Molar.
$\frac{6}{6}$	..	$\frac{1\ 1}{1\ 1}$	..	$\frac{4\ 4}{4\ 4}$	..	$\frac{2\ 2}{3\ 3}$

The claws are long and trenchant, but not retractile, and the wounds inflicted by them, especially on the face, are most ghastly. The native names for the bear are Reech, Bhaloo.

It appears that in 1875, 84 persons and 529 cattle were killed by bears, whilst 1,181 bears were destroyed, at a cost of 4,453 Rs.

The Elephant.—Elephas indicus (Hathi).—Male, without tusks (Mukhna).—Found in most of the large forests of India, from the Terai to the extreme south, and in Ceylon. As a general rule harmless to man or other animals, but occasionally the old males become vicious and dangerous. Separated from the rest of the herd, they lead solitary lives, and vent their spleen on men or animals. In this state they are described as rogues, are very dangerous, and not only destroy life but property, injuring crops, plantations, and houses. For such individuals a reward is sometimes offered, and often the creature is not destroyed until it has done much damage. It is said that male tuskers that have once been in confinement, and have broken loose, are apt to become the most dangerous of rogue elephants, and a very terrible and dangerous brute a *must* wild elephant is. There are certainly two (according to some naturalists, three) species; the Indian, the Sumatran, and the African.

The Indian differs from the African species considerably in the shape of the head, the ears, the formation of the teeth, and the number of nails or hoofs in the hind feet. The head of the African is narrower, and more receding; the ears are much larger. The bone and enamel in the African elephant's teeth are arranged in lozenges; the Indian, in parallel lines. The African has only three nails, whilst the Indian has four, on the hind feet. The tail of the African elephant is shorter than the Indian. The *rugæ* on the trunk are much more pronounced, and the sound of its trumpeting is quite different to that of the Indian. The African male and female both have tusks; the Indian male alone has them and in some cases it has only a small tusk like the female, when it is called "mukhna."

I believe that the African attains maturity earlier than the Indian elephant. The African male in the Regent's-park Gardens is now nearly 11 ft. high, though under 20 years of age, and has for some years had the appearance of an adult; he has been *must* on more than one occasion. The Indian male, so far as I know, never attains the same condition so early in life; seldom before 25 to 30 years of age.

There are other anatomical differences. The Indian elephant has 19, the African has 21, the Sumatran 20 pairs of ribs; the Indian has 33, the African only 26 caudal vertebræ.

The Sumatran seems to resemble the Indian species very closely, and it is thought, I believe, by some authorities, that the Ceylon elephant is the Sumatran variety. More information on this subject is needed. It is curious that the Ceylon male is very frequently devoid of tusks.

It appears that in 1875, 61 persons and six head of cattle were killed by wild elephants, but that only 5 Rs. were paid as reward; five wild elephants were killed.

The elephant destroys his victim by seizing him with his trunk, raising him up and dashing him on the ground, and then crushing him with the tusks, and kicking the body backwards and forwards between the fore and the hind feet. Under native Governments, in former days, the elephant was trained to be executioner, and was taught to destroy the culprit by plucking him limb from limb, by pressure with his feet on the chest, and by breaking his bones. Stories have been told of the very savage wild elephant having not only deliberately plucked off the limbs of the victim but of his having also eaten the flesh. This, I think, is very doubtful.

Rhinoceros indicus, the great Indian rhinoceros, gaindha, found in the Terai, Bhotan, Nepal, Purneah, Assam, in dense jungle and swamps. This animal may cause the death of a few human beings in chance encounters, but it does not appear on the roll of death-dealing animals, and therefore I pass it by with this simple reference. There are other species which are rare, and also not destructive to life.

The Buffalo—Bubolus.—B. arna (Arna Bains).—Common in Assam, Bengal, the swamps of the Eastern Terai, in Central India, and in Ceylon. A very powerful animal, with long sharp scimitar-like horns. The solitary males are very dangerous and vicious, and often make sad havoc among the fields, and occasionally kill men. The same may be said of the bison, or gaur, *Bos avæus* (bun-parra, gauri-gai), and other local names. It is a powerful animal, sometimes standing six feet high, with massive horns. Found in the forests of India, from Cape Comorin to the

foot of the Himalayas, but not in the Oude, Nepal, or Rohilcund Terais. It is common in Assam, in Southern and Central India, but is now extinct in Ceylon. It is a timid and wary animal, but bulls are occasionally dangerous, and cause the death of men, though not to any extent.

Reptilia.—The crocodile, or as it is often, though erroneously called, alligator, is destructive to life, both of men and cattle, and in some places, such as the Sunderbunds, very numerous and dangerous, often seizing human beings who come down to the river to bathe or enter the water for other purposes. Cattle are seized when drinking or swimming across the nullahs. I remember to have seen a man, directly after he had been seized by one of these creatures in swimming accross a nullah, holding on to a cow's tail. The crocodile seized him by the leg, and with such force and determination that the limb was severed at the knee joint, the man, notwithstanding, was dragged on shore on the opposite bank, still holding on, though faint and exhausted. He was brought to the station hospital at Dacca, and amputated, but he died of the shock. With their large peg-like teeth they inflict frightful wounds, tearing the flesh and crushing the bones. They seldom relinquish their hold, the creature is dragged down and drowned, and devoured at leisure. To enable the crocodile to hold its prey under water and drown it without swallowing the water or itself being suffocated, it has an apparatus of flood-gates at the back of its mouth, comprised of cartilaginous flaps above and below, which meet and completely close the entrance, so that water cannot get down through the opened mouth. The nostrils are on the surface of the snout, and they also close like valves; the nose can be kept above water whilst the mouth is immersed. The air passages of the nostrils open behind the septum, so that the creature can remain a long time under water, quite long enough to drown any animal. There are, at least, two species, probably three, of crocodile found in Indian waters—*C. biporcatus* or *porosus*, *C. palustris*, and *C. pondecerianus*. They are known as Muggurs; whilst the Gavial or Gharial (*Gharialis gangeticus*), is known as Nakir, Gharial, Goh, and other names. This Saurian, though generally a fish eater, is not innocent of homicide, and has been known to seize and kill men, though rarely; the remains of human beings, ornaments of women and children, have been found in the stomach. I once saw a man who had been seized by a gharial, when I was travelling in India with H.R.H. the Duke of Edinburgh in 1870. The following is an extract from my diary:—

"Before leaving camp this morning a camel-man of the Maharajah's (Jung Bahadur) was brought in with rather a severe wound in the left thigh, just above the knee. He was wading across the Mohan—which there was not up to his knees—when he was suddenly seized by a large gharial, and dragged down. Some sepoys, who were close at hand, rushed to the rescue, and one of them so severely wounded the great lizard that it let go, and tried to make its escape; he followed, thrusting his bayonet into it, and, having fired all his (six) cartridges, he clubbed his musket, and belaboured it until the stock was broken. The brute by this time was so far *hors de combat* that it turned over, as though dead, and was dragged on shore, and was brought into camp with the man it had bitten. Fortunately, the grip had not been firm, and a portion of integument only, about 5 in. in circumference, had been torn away, leaving a painful, though not a dangerous wound. The gharial was an enormous brute, over 16 ft. in length. He was opened, and his stomach found quite empty, with the exception of about 20 or 30 pebbles, from the size of peas, or marbles, to a hen's egg. These are useful for purposes of digestion, and are, probably, always found in the stomachs of these Saurians. The incident quite settles the question as to whether the gharial does take other food than fish, although, from the conformation of his jaws, he is not able to seize so large a morsel, or inflict so great a wound, as the alligator."

The gharial sometimes devours children, and occasionally seizes the legs of men who venture into the shallow waters in which these creatures abound. About two years ago, Mr. Carleyle, curator of the Riddell Museum, Agra, wrote to the *Delhi Gazette* that the following had been found in the stomach of a large gharial taken near that city:—"About a dozen large bunches, pellets of hair (probably human), 68 stones (rounded pebbles), averaging in size from nearly three inches to one inch in diameter, one large ankle bangle ring of mixed metal, 24 fragments of various sizes, of vitreous armlet rings called 'churis,' five bronze finger rings, one small silver neck-charm (a small defaced coin with a metal loop for suspension attached to it), one gold bead, about one-third of an inch square, one largish bead of black stone, veined with white, called 'Sulimani-manka' (*onyx*), thirty small red necklace beads." All these things (barring the stones) says the reporter, must have been on the body of some young woman or girl (if not more than one), who had been devoured by this monster, which shows that the brute must have had an unfortunate predilection for the weaker sex. And these facts prove the fallacy of the generally received idea that the gharial never preys upon living human beings.

There is no great difference between the alligator which is peculiar to American rivers, and the crocodile of Egypt, Africa, and India. The origin of the name is Lagarto, given by the Portuguese and Spaniards to the huge reptiles that frequented the rivers and estuaries. The difference between them is chiefly this—the head of the alligator is broader, the snout shorter, and the *quasi*-canine teeth of the under jaw fit into furrows in the upper jaw, instead of into foramina or deep grooves, as they do in the crocodile. The legs, too, of the alligator are not denticulated, and the feet are only semi-palmate. The anterior teeth in crocodiles fit into two holes in the upper jaw and perforate it. In both, the size of the jaw is tremendous; they open and close it with a powerful snap. I have seen a mortally wounded crocodile close its teeth so firmly on a log of wood that they were not easily withdrawn. These teeth are deciduous and renewable, therefore the mouth of this formidable creature is always armed. They attain a great size, up to 15, 18, even 20 ft. in length, and are found in many Indian rivers, estuaries, lakes, and tanks, or marshes.

All are bloodthirsty creatures; but they are said to be fonder of carrion than of fresh food. The larger species (*C. biporcatus*), is found near the sea, and in the large rivers and Sunderbund. *Palustris*, which is smaller, occurs in the swamps and pools. The gharial is more of a fish eater, has a very different head and mouth, the jaws are long and narrow, and has rows of closely-set teeth. As I have said, it is not innocent entirely of homicide. It is found in the rivers high up, near the foot of the hills, or in the rapids, and it is generally found to have a number of pebbles in the stomach to assist in the digestion of food.

The shark (*Carcharias gangeticus*). This fierce and bold fish ascends the Hooghly, and probably other rivers, doubtless as far as the tidal water flows, and especially during the seasons when the freshes from the hills fill the rivers fuller then usual. they are occasionally mischievous, seizing people when bathing in the muddy river at the bathing ghâts. They do not often succeed in carrying off the victim, who is generally rescued by other bathers, but inflict dangerous, often mortal, wounds. It is usually in the months of April or May that these accidents occur near the ghâts where formerly the dead were thrown into the water, and where the sharks were wont to seek their food in the bodies that were thrown into the river, imperfectly burned. Since municipal arrangements have provided for complete cremation of all the bodies brought to the ghats, the supply of food for the sharks has failed, and they have turned their attention to the living at the neighbouring bathing ghâts. I wrote the following some years ago in Calcutta in reference to some cases of shark bite that came under my observation in that city.

Shark-bites, I regret to say, occur annually, and they will continue to do so until measures, such as might easily be taken, are resorted to for their prevention. The particular shark (*Carcharias gangeticus*) is a fierce and bold creature; he dashes in among the crowds bathing at the ghâts, and though he seldom, if ever, under these circumstances succeeds in carrying off his prey, yet he inflicts a dangerous, often a mortal wound. These accidents appear to have become more common of late years, since the practice of throwing bodies into the river has been discontinued, and those of the poorer classes have been entirely burned at the municipal expense. Near the great burning-ghâts, where the sharks, no doubt, used formerly to find their prey in abundance in the half, or only very partially, burned bodies then thrown into the river, but where they no longer find them, as they are now completely burned, these accidents most frequently occur; and one or two bathing ghâts near that spot have furnished more victims than others. It is chiefly in the months of April and May, when the river contains much salt water, that the accidents occur, for being then unusually muddy from the freshes, the sharks are not seen as they glide in among the legs of the bathers, and it is only when the shrieks and sudden immersion of one of their fellow bathers give the alarm that the others are aware that the enemy is among them. The noise, the splashing, the shouting, as well as other aid given to the sufferer, save him from being carried off, but not from a severe, perhaps mortal, wound. Up to 1872, when I left Calcutta, no precautions had been taken to prevent this annual loss of life. The mere staking off a portion of the ghât, as is done in the Sunderbunds, against alligators, would be sufficient; but, simple as the expedient is, it had not been resorted to. The people go on bathing at the same places perfectly unconcerned. Indeed, shortly after a person has been bitten, the ghât is again fully occupied by bathers. Every year during these months cases occur, and they are generally taken to the Medical College Hospital.

Ophidia.—The venomous snakes of India are colubrine and viperine. The colubrine are—1. *Naja-tripudians* (cobra); 2. *Ophiophagus elaps* (hamadryas); 3. *Bungarus fasciatus* (yellow-banded snake); 4. *Bungarus cœruleus* (krait); 5. *Xenurelaps bungaroides*; 6. *Callophis* (several species); and then 7. *Hydrophidæ* (sea snakes), all very poisonous. The viperine are—8. *Daboia russellii* or chain viper, *Tic-polonga* (Russel's viper); 9. *Echis carinata*. Crotaline are—10. *Trimeresurus*, *pelleplor*, *Habys*, *hypnale*. They are all poisonous. Nos. 1, 4, 8, and 9, are the most deadly, or, at all events, they are the chief man-slayers. The others, 2, 3, 5, and 7, are very poisonous, but seldom encountered; 6 and 10 are comparatively harmless.

A full description of all these will be found in the "Thanatophidia of India," and also an account of the physiological action of their poison, and the extent to which they contribute to the death-rate in India.

LOSS OF LIFE IN INDIA BY WILD ANIMALS AND SNAKES.

ANIMALS.	KILLED IN 1875.		KILLED IN 1876.	
	Persons.	Cattle.	Persons.	Cattle.
Elephants	61	6	52	3
Tigers	828	12,423	917	13,116
Leopards	187	16,157	156	15,373
Bears	84	522	123	410
Wolves	1,061	9,407	887	12,448
Hyænas	68	2,116	49	2,039
Other animals	1,446	3,001	143	4,573
Snakes	17,070	3,166	15,946	6,468
Totals	20,805	46,805	18,273	54,430

WILD ANIMALS AND SNAKES DESTROYED AND REWARDS GIVEN.

ANIMALS.	IN 1875.				IN 1876.			
	Destroyed	Rewards.			Destroyed	Rewards.		
		R.	A.	P.		R.	A.	P.
Elephants	5	5	0	0	4	50	0	0
Tigers	1,789	41,212	8	8	1,693	43,598	12	0
Leopards	3,512	35,756	14	8	3,786	33,972	12	0
Bears	1,181	4,453	0	0	1,362	4,915	6	0
Wolves	5,683	15,185	12	0	5,976	18,633	12	0
Hyænas	1,386	3,602	4	0	1,585	3,650	12	0
Other animals	8,801	3,251	6	0	8,053	3,985	2	0
Snakes	270,185	16,548	11	6	212,371	15,757	12	6
Totals	292,542	120,015	8	10	234,830	124,564	4	6

WILD ANIMALS DESTRUCTIVE TO LIFE IN INDIA.

CARNIVORA.

FELIDÆ.

Felis—*F. leo* ....Lion.
F. tigris ....Tiger.

F. pardus ....Leopard.
F. jubata ....Hunting leopard.

HYÆNINÆ.

Hyæna—*H. striata* ......Striped hyæna.

CANIDÆ.

Canis—*C. pallipes*........Wolf.
C. aureus ....Jackal.

URSIDÆ.

Ursus—*U. isabellinus* ....Brown bear.
U. tibetanus ......Black bear.
U. labiatus ......Sloth bear.

UNGULATA.

ELEPHANTIDÆ.

Elephas—*E. indicus* ....Elephant.
Rhinoceros—*R. indicus* ....Rhinoceros.

SUIDÆ.

Sus—*S. indicus* ....Wild boar.

BOVINÆ.

Gavæus—*G. gauri* ....Bison, gaur.
Bubalus—*B. arni* ....Buffalo, arna.

SAURIA.

CROCODILIDÆ.

Crocodilus—*C. palustris* ......Crocodile.
C. biporcatus...... „
C. pondicerianus .. „
Gharialis—*G. gangeticus* ....Gharial.

PISCES.

CARCHARIDÆ.

Carcharias—*C. gangeticus* ....Ground shark of Ganges.

POISONOUS SNAKES OF INDIA.

Those marked with an * are most deadly; those marked with a † are most common among the most deadly.

POISONOUS COLUBRINE SNAKES.

ELAPIDÆ.

1. *Naja*..................*N. tripudians*†, cobra, several varieties.
2. *Ophiophagus* ....*O. elaps**, hamadryas.
3. *Bungarus*..............*B. cæruleus*†, krait.
   „ ....*B. fasciatus*, sankni.
4. *Xenurelaps* ....*X. bungaroides*.
5. *Callophis* ....*C. intestinalis*, and several other species.

HYDROPHIDÆ, OR SEA-SNAKES (ALL DEADLY).

1. *Platurus* ....*P. scutatus*, *P. Fischeri*.
2. *Hydrophis* ....*H. cyanocincta*, and several other species.
3. *Enhydrina* ....*E. bengalensis*.
4. *Pelamis* ....*P. bicolor*.

VIPERINE SNAKES.

CROTALIDÆ, OR PIT VIPERS.

1. *Trimeresurus* ....*T. gramineus*, and several other species.
2. *Peltopelor* ....*P. macrolepis*.
3. *Halys* ....*H. himalayanus*.
4. *Hypnale* ....*H. nepa*.

VIPERIDÆ, OR TRUE VIPERS.

1. *Daboia* ....*D. russellii*, chain viper, Tic-polonga.
2. *Echis* ....*E. carinata*, Phoorsa snake, Afaë, Kuppur.

SCALE OF REWARDS IN INDIA FOR THE DESTRUCTION OF SNAKES AND WILD ANIMALS IN 1875.

	Snakes.	Alligators.	Bears.	Buffaloes.	Cheetahs.	Elephants.	Hyænas.	Leopards.	Lions.	Panthers.	Rhinoceri.	Tigers.	Wolves.
		Rs.	Rs.		Rs.		Rs.	Rs.	Rs.	Rs.		Rs.	Rs.
Bengal	4 Ans.	...	1¼ to 2½	...	...	...	1 to 2	2½ to 10	...	...	...	12½ to 50	5 to 20
Berar	...	...	5	...	...	...	5	...	...	...	...	10 to 20	3 to 5
Bombay	6 Ps. to 4 Ans.	...	3 to 12	...	3 to 12	...	...	3 to 40	...	3 to 12	...	6 to 60	4
British Burmah	...	5 to 20	5 to 10	...	...	...	...	5 to 10	...	...	...	5 to 20	...
Central Provinces	1 R.	...	2 to 5	...	5 to 10	...	½ to 2	5 to 10	...	5 to 10	...	10 to 100	2 to 5
Hyderabad. Nizam's Territory	8 Ans. to 2 Rs.	...	5	...	...	...	...	...	...	10	...	20	...
Madras	1 An.	...	5	...	25	...	3¼	...	...	...	...	50	5
Mysore	8 Ans.	...	...	...	...	...	...	...	...	15	...	35	...
North-West Provinces	2 Rs.	...	3	...	...	...	...	5	...	...	...	10	6
Oude	..	...	...	...	...	...	...	...	...	...	...	...	1 to 6
Punjab	2 Ans.	...	...	...	...	...	...	...	25 in Ketah	...	...	...	...
Rajpootana	1 to 8 Ans.	...	5	...	...	...	...	5 to 10		...	...	10 to 15	5

GRAND TOTAL OF DEATHS FROM SNAKE-BITES IN 1869.

Population, excluding that of Central India, 120,972,263.

Provinces.	Males over 12.	Females over 12.	Males under 12.	Females under 12.	Names of Snakes.				Total Deaths.
					Cobra.	Krait.	Other Snakes.	Unknown.	
Bengal	2,374	2,576	663	606	959	160	348	4,752	6,219
Orissa	137	138	44	31	128	2	52	168	353
Assam	50	14	9	3	...	...	12	64	76
North-West Provinces	654	252	199	90	854	92	63	986	1,995
Punjab	434*	184*	77*	32*	76	...	242	437	755
Oude	364	558	137	146	607	105	20	473	1,205
Central Provinces	...	...	...	...	...	...	...	...	606
Central India	38	36	8	8	21	...	37	32	90
Burmah	95	22	3	...	45	...	65	10	120
Grand Totals	4,416†	4,480†	1,140†	1,016†	2,690‡	359‡	839‡	6,922‡	11,416

The addition of 28 (from Umritsur) to the totals marked * will give the grand total 755. The addition of 606 to the totals marked † will give the grand total 11,416. The addition of 634 (*i.e.*, 606 + 28) to the totals marked ‡ will give 11,416. About 1 death in every 10,000 persons. These abstracts are made from Government returns, which are, however, imperfect in details.

DISCUSSION.

Mr. Cook quoted a newspaper paragraph showing that, in 1876, 21,391 persons, 48,234 cattle, and 12,000 sheep were killed by wild beasts. A very interesting work on this subject was published in 1807, by Captain Williamson, entitled "Wild Sports in the East." Wild beasts had been destroyed in England in consequence of the rewards offered for them, and he did not see why the same means should not eventually be effectual in India.

Rajah Ram Pal Sing had been very much pleased with the paper. Some things, however, had been omitted, for instance, the bites from mad jackals and wild dogs were very destructive. The reward fixed for wolves and snakes was so little that no one ventured to take the trouble to kill them. Some men professed to catch snakes, and were very clever in catching them, so as not to get bitten, and if they were bitten went to those who professed to cure them; and this belief that snake-bites could be cured, he had no doubt was very prejudicial.

General Abbott said, when he was a young lad in India, they used to dig pitfalls, baited with a young kid or sheep, to catch wolves. A brother officer of his came up to one, and found in one corner a wolf, in the other a dealer in grain, and in the third a jackal, all three so afraid of each other they did not know what to do. Therefore, that method seemed rather dangerous. With regard to alligators, there were three kinds, and he remembered, on killing one once, and cutting him open, they found the skin of a woman, almost perfect, with bangles and ornaments; the bones and flesh were digested, but the skin was almost perfect. He knew from several instances that jackals sometimes attacked human beings.

Mr. Frank Buckland considered this question of the highest interest. The science of natural history was now very much applied to practice, and he wished to give two instances of destructive animals which had now been almost totally exterminated. In the West Indies rats were very destructive to sugar canes, but they were now pretty nearly extinct by the simple plan of letting loose the rats' natural enemy, the mongoose. The next instance, that of poisonous snakes, was also in the West Indies. A gentleman interested in the destruction of snakes in the sugar canes, came to his friend, Mr. Jamrach, the animal dealer, and offered him a large reward to tell him what animal would destroy snakes in the sugar canes. Mr. Jamrach said, "What will you give me?" and on his price being agreed to, he said "peccaries." Then peccaries were turned loose and the snakes disappeared, but Mr. Jamrach never got his fee. When his friend, Captain Rogers, first brought this matter before the public he took a great deal of interest in the matter. With regard to tigers, he should lay drags for them; they would go anywhere after valerian. If you wanted to annoy a neighbour you could not do it better than putting a handkerchief with a drop of valerian on it into his garden, when all the cats in the neighbourhood would assemble there. He tried it at the Zoological Gardens with the tigers, when he found they rolled over it and appeared thoroughly delighted. A gentleman on the right had mentioned wolves; if he had a chance he would catch most of them. He would run a drag of red herring in their way, and thus you could lead wolves where you liked, and shut the door after them. Strychnine was used largely in Ireland for killing magpies, also in Australia, and he did not see why it should not be used for killing tigers. He exhibited a model of Capt. Rogers' tiger trap, and explained its operation. With regard to sharks, he would soon polish them off. It had been the habit for the last two or three years for people to use dynamite for killing fish. As Inspector of Fisheries, he and his colleague had held several inquiries into the action of dynamite; it was most terrific stuff. A cartridge of dynamite such as those used at Portland, that cost 2d., would be thrown into the water, and one man confessed to thus catching 340 mullet. Dynamite had been made totally illegal in England for fish, but he did not see why it should not be used for sharks in India. He would get them together like roach with ground bait. If they wanted to get rid of cats, he would tell them an infallible remedy, viz., the common star fish fried. When a boy he used to kill cats with piano wire three times twisted, and he did not see why the same method should not be tried with tigers.

Dr. Rae said he might mention the way in which Esquimaux caught wolves and wolverines. They selected a drift of snow, dug a pit, and covered up the surface with flakes of snow. If a wolf came up to it he would know it was hollow, and would not go upon it, but the Esquimaux built a little wall round it which the wolf had to jump over, and then he jumped down into the pit. That was the best protection for a pitfall; it made wild animals go into it, and showed a passer by that there was danger. Then they had a plan of setting spring guns which was perfectly safe. If a wolverine saw a line he would not go up to the bait; but his old Esquimaux interpreter took another plan; he covered up the gun with snow, leaving nothing but the muzzle visible and to that he attached the bait.

Dr. Chevers said Sir Joseph Fayrer had, perhaps, exercised a wise reserve in not alluding to one point, but it might be as well to mention it. Many persons experienced in the ways of India had a strong suspicion that many of these deaths ascribed to wild animals, especially venomous serpents, were really not accidental, but homicidal deaths; and, as Sir Joseph suggested the institution of civil commissions to inquire into this, he thought that it would be well if, in all cases, the civil surgeon should be placed in communication with the commissioners, so that it might be ascertained whether these cases were not sometimes homicidal. He fully admitted, and was glad to admit, that there was very little proof of the suspicion, but it was noticed that a large number of those who so died were females, and there was a native saying that the snake was frequently a husband. If the suspicion were true, let the fact be revealed; but, if untrue, let the country be relieved of the imputation. It happened to him once to have the dead body of a poor native brought in to him, who had been pierced through an artery of the leg by a sort of tiger trap; but not Capt. Rogers's, as it was before his time.

Mr. Dutt had listened with great attention and interest to the paper. It appeared that nearly 17,000 human lives were lost every year from this cause. Dr. Chevers had said that in many of these cases death was due to negligence or ignorance. It was quite true that the Hindoos from superstitious motives would not kill the snakes; and he doubted very much if the figures given there of 165,000 killed was correct. It was said that some people would breed them to get the reward. Snakes multiplied very rapidly, and he had been told on good authority that, when a reward was offered, some snake charmers actually bred snakes, and killed them to get the reward. With regard to the best means of preventing deaths from snake bites, they knew that snakes had to struggle for existence, and they had many enemies besides human beings. Tigers killed them; the snakes themselves killed their young; vultures and other birds killed them, and there was a little weasel which also killed them. But for this the number of snakes would be very large, and the number of deaths would be 50 or 100 times more. The greatest enemies to the snakes were the weasels, and if they could be encouraged snakes might be diminished. Many of the deaths arose from a kind of nervous paralysis, not from the actual poison. He knew a case where a man was supposed to be dead, but when he was brought on the

funeral pyre and half burned he came to life. He had seen cases where a person in a state of coma was cured by a vapour bath. No amount of reward would lead the superstitious Hindoo to kill snakes, except certain classes, such as snake charmers. The Hindoo believed that if a snake was killed by a Hindoo, all his relations would be killed by other snakes. One kind of cobra, which showed a kind of phosphorescence on his hood at night, was held in especial veneration.

Mr. Endean asked if the spirit of veneration entertained by Hindoos for the snake, existed in the same proportion amongst the Mohammedan population?

Sir Joseph Fayrer said he had not had time to read all the paper, and some of the remarks made would be met by reading it in full. He wished Mr. Frank Buckland would go to India, and that the Government of India would put the matter in his hands; but he was perfectly certain of one thing, that, although there could be no one who would devote himself more zealously to the work, there would be no one who would come back and more thoroughly confess that he had been altogether mistaken in his views. But he did believe that, from his energy and love of sport, and the intense interest he took in this subject, he would contribute immensely to the object aimed at. Mr. Buckland had seen a great deal, but had never seen an Indian jungle, and the sort of cover in which tigers were found; when he had done so, he would at once abandon the notions he had propounded. As to sharks, he was probably thinking of the ordinary shark that swam about in the ordinary clear water of the sea; but he spoke of the ground shark which lived and carried on its dreadful course in the rapid muddy stream of the Ganges; he dashed in among the ghâts, and was off in a moment with his victim. If Mr. Buckland could catch the sharks altogether, and then put some dynamite amongst them, no doubt it would answer well. General Abbott had alluded to the wolves at Cawnpore. It always had an evil reputation for wolves, and had still. He had no doubt the experience gained there was valuable, and there was reason to hope that the wolves there were decreasing. On the whole he believed that there was a tendency to the diminution of these animals. The Government was alive to the evil, but the mistake was there was not sufficient concentration in their efforts. A system was wanted; he only ventured to sketch faintly the idea, but if that were filled up in detail, he believed it could be worked out. He did not speak from mere theory, but from experience. He had killed a great many of these wild animals himself, and knew something of their ways. He had no doubt such a plan as that recommended by Dr. Rae would be suitable with wolves, but feared it would not be of much service with regard to larger animals. Dr. Chevers was a great authority on subjects of medical jurisprudence, but he was induced to think that although there might be some cases of homicide, the great mass of these cases were genuine, and that the numbers were really much understated. He had the exact details of the cases which were included in the tables, and in many instances could give the names and residences of the victims. When one province returned 5,000, and another more likely to be ravaged gave only 400, it looked as if there were great omissions. He believed the Mohammedans of India, although they had adopted many Hindoo prejudices, had not taken to this superstition with regard to snakes. There were many Hindoos also who were quite as ready as other people to kill snakes. But as a magistrate once said to him, how could you expect a man to risk his life for three halfpence? He did not believe the stories of breeding snakes for the sake of the reward, although he had heard them. It would not pay.

The Chairman then proposed a hearty vote of thanks to Sir Joseph Fayrer. Having had a pretty wide experience he could confirm a great deal of what had been said. With regard to the larger animals they were all entirely agreed, and it was only a matter of detail what were the best means by which they could be exterminated. He believed that with the progress of cultivation the larger animals were being rapidly driven back. After all, the tiger was a cowardly brute, and did not much care to face man. It was shown that, on the whole, he had not a preference for human food, but that those who took to this were the old decrepid ones, who could not get anything better. Wolves, on the other hand, were animals which much more haunted the neighbourhood of civilisation. They thronged about Cawnpore, Lucknow, and many other important stations, but they led so quiet and secret a life in the ravines during the day that it was difficult to capture them. They destroyed a large number of children, having a particular taste for babies, of whom they carried off a great number in Oude. There was a belief that these wolves, when they were childless, sometimes carried off and adopted human children, and brought them up as their own cubs. When he was at Lucknow there was a child said to be a wolf-child, and to have been captured from a wolf's den in the jungle. It was a savage ill-mannered creature, but they could never make out whether it was an idiot, or one which had been really suckled and adopted by wolves, as asserted. He could assure the meeting that the Government and all its officers were anxious to do all they could to put down the evil which had been spoken of. The most effective means was the offer of rewards, and he believed that in every province, according to the circumstances, adequate rewards were offered, and the result was that a large number were killed. No doubt poison was very effective, but there was another side to the question. It was not desirable to make poison too common in India. Dr. Chevers had alluded to the suspected use of snakes by husbands to get rid of their wives, and unfortunately also sometimes the wives took the law into their own hands. In the good old days Suttee was a very horrible thing, but it was a useful check on troublesome wives, because if they got rid of their husbands they knew very well that unpleasant consequences would follow to themselves. But now-a-days, in some parts of Bengal, it was remarked that since widows possessed great privileges their number was very great. He should be rather in favour of Mr. Frank Buckland's method of killing the animals by kindness; bribing them with valerian or a red herring. The next time there was a select party of wild beasts found in a hole with a human being, he hoped that human being would be Mr. Frank Buckland, and he had no doubt he would give a good account of them. The most important part of the question was that of the snake bites, since five-sixths of the whole deaths arose from this cause. He was not inclined to think that a large proportion were really murders, but he believed many were deaths that could not be otherwise accounted for. When a person died, and you could not exactly account for death, it was a common thing to put it down to a snake-bite. Still, no doubt, there was an immense mortality from this cause. He did not believe stories about breeding snakes for sale, although he believed many snake charmers caught snakes which were pretty well tamed before they were caught. There was, however, the difficulty in distinguishing between poisonous and non-poisonous snakes; he could not himself, although he lived many years in India, and it was found that, when rewards were given freely, snake catchers went out into the jungle, where they were very numerous, and brought snakes in. Therefore, the Government found it expedient to offer a moderate, not too large, a reward. The result was that 270,000 had been killed in one year. The great difficulty was to distinguish between poisonous and non-poisonous; for that the only remedy was increase of knowledge and education, and no one had done so much in that respect as Sir Joseph Fayrer. As this knowledge became more

diffused, the more effectively could the numbers of these destructive animals be reduced.

The vote of thanks was carried unanimously, and the proceedings terminated.

NINTH ORDINARY MEETING.

Wednesday, February 6th, 1878; James Mc'Clelland, Esq., in the chair.

The following candidates were proposed for election as members of the Society:—

Albano, Benedict, 75, Welbeck-street, W.
De Avendaño, Don Teodomiro, 178, Hampstead-rd., N.W.
Farquharson, Robert, M.D., 23, Brook-street, Grosvenor-square, W.
Hutton, Darnton, care of Messrs. Henry Lee and Son, 5, Westminster-chambers, Victoria-street, S.W.
Liley, Henry G., 5, Bradmore-park, Albion-road, Hammersmith, W.
Schwarz, Gustave F. C., Ph.D., High School of Trade and Commerce, Queen's College, Birmingham.

The following candidates were balloted for and duly elected members of the Society:—

Bailey, William, Horseley-fields Chemical Works, Wolverhampton.
Bethell, Charles, 38, Wood-lane, Uxbridge-road, W.
Byramjee, Rustomjee, M.D., F.C.S., 131, Inverness-terrace, W.
Faulkner, Robert, 20, Baker-street, W.
Ford, W., 5, Copthall-buildings, E.C.
Fynney, F. B., Pietermaritzberg, Natal.
King, Henry S., J.P., 65, Cornhill, E.C., and The Manor-house, Chigwell, Essex.
Newton, Harry Robert, 43, Seymour-street, Hyde-park, W.

The paper read was—

HIGHER COMMERCIAL EDUCATION.

By John Yeats, LL.D.

Education, in the popular acceptation of the term, is understood to be professional or commercial—equivalent, in one sense, to the German expression, *Gymnasial* or *Rëal*. We are concerned mainly with the latter of the two.

By higher commercial education I do not mean that which leads a youth to look merely for a higher rate of interest on capital, or of profit in business, but that which trains him to appreciate fully the "objects, advantages, and pleasures" of a commercial calling. Such an education should fit him to compete with all comers; to be prepared to keep faith with everybody; to value justly whatever is valuable; but not to expect uniformity of weight, measure, custom, or opinion throughout the world.

The higher the education, the broader and deeper and better prepared should be the basis on which it is raised; but I cannot begin at the bottom tonight. I propose addressing myself to young men principally, to such as come up to the examinations of our Society. My remarks will be intended to facilitate their work, by showing its nature and extent, and also the sources of information accessible to them at home and abroad. I shall be glad, moreover, to convince all that the literature peculiar to business—statistics, Blue-book reports, and even the census—is less dry than is sometimes supposed. It will be right, on a subject of so much importance, to adduce evidence from recognised authorities.

Opinions of the Press.

In the middle of January, 1874, the *Times* said, truly:—"England has been made what it is, not so much by the virtues of her people, as we fondly imagine, as by causes of a special and a transient character. . . . Already, in many forms, we see the fatal signs that the commercial monopoly, which was ours, is departing from us. The prizes of this world are for those who are qualified to run and win. No sooner does a man of keen observation and large experience, such as Sir Bartle Frere, see the Germans coming ahead, than a whole multitude of witnesses from unexpected quarters give the same note of warning. Germans, Italians, Greeks, and other foreigners have long found it easy to master, and in some instances monopolise, important branches of industry in this city and country. . . These nations are not only sharing the ground we have acquired in foreign commerce, but are actually displacing us. They increase and we decrease."

One who has borne his part manfully in the great commercial struggles of Germany, Dr. Von Steinbeis, of Stuttgart, thus expressed himself in the preface to a recent work, "Jahresberichte der Handels und Gewerbekammern, in Württemberg," 1876:—"There are indeed some who find competition disagreeable; who ask for protection against the motive power that forces them along, and assures them a future because it keeps them on the path of progress. Let us calmly leave to other nations the glory of such protection, which is often only a protection against laziness, and excessive dearness, disturbing both imports and exports, and let us, on the contrary, try to form for ourselves, by the side of a worthy working-class, a worthy commercial class also. It is, and will ever be, a great mistake if any individual expect any real improvement of his position from protection as a bulwark. Safety is only to be found in himself; he must begin by self-improvement instead of waiting for help from without.

"It has been rightly said that the question of elevating our industrial life really resolves itself into a question of culture, but culture in the complete sense of the word, that which cannot be conferred in schools, but of which the true foundation must be laid in every home,* and to which the whole of life must contribute, we mean the thorough training of conscientious, practical and prudent men of business. In such training, all the economic virtues find their substance and their guidance. . . . When every man seeks honour and profit only in doing his best, he will serve himself and the community; the material prosperity of the one and the material prosperity of the whole will be inseparably united."

Thus, self-improvement, self-culture, are the things required; but they spring only from strong motives to exertion; and it will be far more difficult for me to find these, than to say where groups of young men may be seen collected, in other

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* To accomplish this, itinerant teachers have been sent through the rural districts of Würtemberg to teach bookkeeping to females. To reach the humblest, and furthest from towns, a book of questions has been drawn up for clerks and artisans. For specimen tables see Appendix.

countries, listening to discourses, from distinguished professors, provided by the State. However, I will point to those which are sufficiently plain.

Public Requirements.

During our long industrial depression and suffering, there have been many public meetings held, and many modes of relief proposed. Perhaps a new mode of relief may be opened, if in the treatment of my subject I can point out a connection between commercial knowledge, and commercial power; and some old sources of suffering may be dried up, should I succeed in showing that in one country, at least, strikes have been long prevented, if not positively put an end to—mainly through higher industrial education. This last has already demonstrated, as nothing else has done, that industrial union is industrial strength.

The conclusions arrived at in those meetings may be thus summarised:—"It is desirable to obtain new materials for manufacture, or new aids of some kind to production; new markets for our goods; and a better understanding between master and man." At the Carnarvon Eisteddfod in August last, a few commercial travellers took a practical and praiseworthy step. They offered a small prize of twenty guineas for the best essay on "The Trade and Commerce of North Wales; with suggestions for the introduction of new industries."* I regret to say that no fitting response was elicited; notwithstanding the great activity of the last thirty years, and repeated exhibitions of raw materials and manufactures from all parts of the world.

Commercial education should satisfy commercial requirements, which can be ascertained only from a knowledge of the functions of the mercantile classes. They are partly set forth in the Census Vol. IV. The divisions and sub-divisions of Class III. may safely be omitted here.

Functions of the Mercantile Classes.

These functions have sometimes been limited to the distribution of commodities, in contra-distinction to the production of them; but how long would the latter be maintained without the former, or with what regularity? Again, it has been said that merchants deal in products, but are not concerned in processes as manufacturers. Yet they have to deal largely in stocks and goods while passing through stages of preparation, and a steady succession of products is of the highest importance in the organisation of industry. The intervention of the merchant is found to be necessary to a continuous activity of the farm, the mine, or the manufactory. In our day, the wool grower could not spin, weave, dye, and carry his fleeces to market, any more than the miner could convert the ironstone into pig-iron, malleable iron, steel, and finally knives, swords, or needles,—or the cotton planter act severally for the importer, the manufacturer, the merchant, and the retailer of calico.

Moreover, products have to be preserved,—if produced only annually, like hops and barley, but wanted for consumption daily. Merchants take charge of them and equalise their distribution in time and place. Foreign wheat stored in London acquires additional value because it has become accessible when most wanted; in other words it has acquired increased utility. A banker stores and distributes securities; a shopkeeper goods. Brokers, agents, salesmen of all sorts, are concerned either in collection or in distribution.

Commercial Training Abroad.

I said what commercial education should do; but in our use of the expression higher commercial education, one possible mis-conception must be guarded against. As may be observed on the diagram on the wall, higher commercial schools on the Continent are special schools; though scarcely so amongst us. In every country possessed of a system of national instruction, commercial instruction is quite special. It ranks with higher technical instruction. From this difference between ourselves and neighbours, a matter of importance follows. It is this: while in England by commercial education we commonly mean the mere preparatory school-training received by a boy, for the performance of purely subordinate duties, in France, Holland, Switzerland, and Germany, the same expression would mean considerably more. Nor is this merely a distinction of degree. The one training is limited to adapting a boy for any indefinite kind of business, the other gives a training that fits a youth for some definite kind of mercantile occupation for discharging onerous duties, and accepting serious responsibilities. In all probability it also gives the latest, the best, and most comprehensive views of that particular occupation, and thus tends to improve it gradually; and so brings the means of living, ultimately, more into harmony with the true ends and aims of life, a matter, it may be, of some social as well as individual advantage.

Leipzig.

From many before me I present an English prospectus of the Public Commercial School in Leipzig:—

Acting upon the conviction that a mere practical apprenticeship, in any branch of commercial life, is no longer sufficient of itself to form able men of business, the Council of Commerce of the City of Leipzig, out of the funds of the Corporation of Tradesmen, established an institution in which all those sciences are taught which are requisite for the practical and scientific education of the future merchant.

The statutes having received the royal sanctions in the year 1831, the Commercial School was opened in the same year.

Its object is two-fold:—

1. To enable all apprentices in the City of Leipzig, as far as their circumstances will allow, to enjoy the advantages of a scientific education in accordance with the present advancement of knowledge.

2. To give youths, who intend to devote themselves to commercial life or to any other kindred higher calling of civil life, the necessary education in the requisite arts and sciences.

This it proposes to attain by a three years' course, and the following plan contains the terms and objects of instruction.

The management and inspection are in the hands of the Council, consisting of members of the Council of Commerce and of the Director. An annual report of the progress of the school is made to his Excellency, the Saxon Minister of the Interior. The school, which

* In the transactions of the Cymmrodorion Society of London, the patriotic editor, Rev. Robert Jones, of Rotherhithe, has published a list of thirteen subjects. See January No., 1877, page 47, "Manufactures." In the programme for the Eisteddfod at Birkenhead this year, larger prizes are offered for industrial subjects.

is situated in the most healthy part of the city, contains 14 fine large class-rooms, with a garden for the recreation of the pupils. It possesses a rich library, a cabinet of objects of natural history and philosophy, and complete collections of goods, coins and mining products.

Plan of Instruction.

Course, three years. Thirty-four weekly lessons in several classes.

Instruction is given in the German, English, French, and Italian languages; mathematical, physical, political, statistical, and commercial geography; commercial statistics, universal and commercial history, mathematics, natural history, physics, chemistry and mechanical technology, knowledge of goods, commercial science, practical and theoretical, namely: commercial arithmetic and accounts, book-keeping, correspondence in four languages, commercial legislation, particularly commercial, exchange, and maritime law, political economy, calligraphy and drawing.

Marseilles.

From the Higher Commercial Institute of Marseilles, I select so much as relates to law and political economy:—

The teaching of commercial law is the principal object of this course; it embraces two years; and its aim is to give the pupils first principles, which will ultimately facilitate further knowledge of commercial jurisprudence, if circumstances require it, or taste incline to it.

The course of the first year opens with this study. The pupils have in their hands an elementary treatise, which aids them in following the professor in his oral exposition; the use of synoptical charts completes the instruction.

The civil code is then taken up, but only summarily; and followed by lessons on political economy, serving as a transition to the study of commercial laws.

In this abridged course an endeavour is made to follow the development of wealth in its three phases, of production, distribution, and consumption.

The teaching of the first year is generally terminated by lessons on the functions of commerce, on commercial agents, and commercial associations.

The second year is entirely devoted to the study of commercial law, divided into three parts—commercial law properly so-called, maritime law, and industrial law. The teaching in this part of the course comprises the explanation—for commercial law, of the I., III., and IV. books of the Code of Commerce; for maritime law, of the V. book; for industrial law, of the special laws; such as those on patents, counterfeits, dangerous or unwholesome occupations, apprenticeship, employment of children in manufactures, customhouse legislation, industrial or commercial delinquencies.

The course is completed by instruction in the matters following:—

1. Summary lessons on the duties of merchants.
2. Explanation of the commercial laws of foreign powers, chiefly England and the United States.
3. French jurisdiction and procedure in the ports of the Levant.
4. Organisation of the French marine, especially the mercantile marine, with an exposition and analysis peculiar to the latter.
5. Principles of natural and of international right; their applications to the rights of neutrals; legislation on maritime capture, &c.
6. History of treaties of commerce.
7. History of political economy.

Holland and Switzerland.

In Holland and Switzerland, after mathematics, physics, and chemistry, the science of commerce, as it is expressively termed, proceeds to a study of *De wetenschap der volkswelvaart*—or, as the Germans call it, *volkswirthschaftslehre*—referring, rather, to the inherited advantages, and the consequent duties of citizens, than to their real or supposed social rights. Long studies in trade museums follow—Lord Bacon's "Colleges of Inquiry," as distinguished from colleges of reading—involving examinations and comparisons of the raw products of the earth, their geographical distribution, and their economic uses. With them comes the history of inventions and discoveries, the steps by which processes at first rude and traditional have developed into scientifically accurate and delicate operations. Next, an account of the origin and growth of trade; its advantages to individuals and to nations; its expansion into international commerce. Then, the progress of the institutions devised to facilitate commercial transactions, account keeping, banking, exchange, insurance, living languages, maritime law, transport, &c., together with historical examples of the violation of moral and economical principles expressed in the policy of some States.

Surely, it is not too much to say that the pursuit of knowledge such as this must excite a warm interest in the causes and conditions of commercial prosperity! In the preservation as well as in the creation of it!

For examples of the careful development of different branches of these courses, and of their application to commercial wants, let me refer to such reports as that of M. Moréno Henriqués ("Statistique de l'Industrie à Paris, résultant de l'Enquête faite par la Chambre de Commerce, 1860"), which gives in detail the history, progress, and present condition of 20 great groups of industries in that city, and of their numerous subdivisions; or, to "The Industrial Development in the Kingdom of Württemberg, and the Working of its Central Institution for Industry and Trade during the first 25 years" ("Die Industrielle Entwicklung im Königreich Württemberg, und das Wirken seiner Centralstelle für Gewerbe und Handel in ihren ersten 25 Jahren"), one of the most remarkable records of the age. Or, for treatises adapted for private study, to "Les Ouvriers Européens," "Les Ouvriers des Deux Mondes," "Annales du Conservatoire des Arts et Métiers," &c. To others, in German, on "Waarenkunde, Werkzeugkunde, Handwerkskunde, and Handelswissenchaft," "Bildungsgang und Bildungsmittel der Menscheit, &c."

The Study of Modern Languages,

But a commercial education is not only special, it is early in its commencement; this for the sake of the acquirement of living languages. There is a common saying on the Continent, "The more tongues, the more times a man." Moltke is called the "Silent in seven languages." The methods of learning differ from our own essentially. More time is devoted to the work, and more help from natives is obtained. We in England appear to value written more than spoken language. The two differ widely even in idiom, to say nothing more. The "Lautir" or phonic system prevails universally, with modifications of Jacotôt's plans. Of these we seldom hear anything in England now, though the case was different fifty years ago. He

was a military officer in a military school at Louvain, and his methods applied to nearly every branch of study. Reports of that day said that, "experience has proved this to be the shortest and cheapest method for the general diffusion of knowledge." The officers of that school introduced the method into all the regiments of the Netherlands.

We have heard that, from our negligence in the matter of languages, English trade is supplanted in many countries; that a German or Swiss is more studious and more apt as a linguist than an Englishman, and therefore more useful abroad as a clerk and a correspondent. But that he can and does, "sooner set up for himself as a broker, small store-keeper, or in a petty commission agency, and connect himself with houses in his own country rather than in ours." Our insular position may have made us indifferent to such studies; but we must not forget that the sea does not divide the nations who compete with us. Modern railroads unite them, and make it a necessity for every man who looks after his own business to be able to converse in modern tongues. Besides, a good linguist can get information at first hand, and form opinions for himself, instead of adopting those of interested persons

One member of our Council, Mr. Hyde Clarke, has strongly advocated practical measures, and mentioned as the languages required, Dutch, German, Russian, French, Portuguese, Italian, Turkish, Arabic, Hindostanee, and Indian vernaculars, with Japanese and Chinese.

With regard to these last, Professor Legge, of Oxford, has given some valuable particulars. I avail myself of these gladly, from their importance in relation to our trade in the East. In his inaugural address, he says, "There is in Paris, L'Ecole spéciale des Langues Orientales Vivantes; the teaching in which embraces Chinese, Japanese, Annamese, Hindustani, Persian, Turkish, and other Eastern languages. Each department is conducted by a French professor, assisted by a native scholar of the country, the language of which is being taught. The provision thus made in Paris for the training of young men in a knowledge of Chinese and other Eastern languages, is as complete as it well could be." Germany was later than France, and not earlier than England in taking up the study of Chinese.

In 1838, a chair of Chinese and the Tartar languages, to which Finnish has since been added, was established in the University of Berlin, with Dr. William Scholl as Professor Extraordinary. Chinese chairs exist also at Münich and at Vienna. In Holland, in 1850, Professor Hoffman began to give instruction in Japanese and Chinese at Leyden. Of late years Professor Schlegel has trained Chinese interpreters for service in the Dutch East Indies. Since 1864 the Italian Government has promoted the study of both Chinese and Japanese. At Irkutsk, in Asiatic Russia, there is a faculty of Asiatic languages. At Kasan, in European Russia, the chairs for Tartar and Mongolian, founded in 1828, have been transferred to St. Petersburgh, where there is a Professor of Chinese and Manchu, and likewise periodical Government examinations.

Uses of Travel and Research.

Let us turn now from the acquisition of living languages and of scientific knowledge, to their natural result—travel and research. How many go out into the world to seek a fortune, quite unprepared to find it, or to recognise it when it comes in their way. Industrial history abounds with illustrations of the fact. I select a few. Providence has distributed through the three kingdoms of nature innumerable raw materials useful in industry; but it is very remarkable that during the last forty years, scarcely twenty new products of importance have appeared; and, curiously enough, their introduction has been due to the chance of their having come under the notice of an observing eye. M. Bernardin, of Melles-lez-Gand, gives the well-known instances of the discovery of gutta-percha, the piassava, alpaca wool, and even the rejection of the first bale of cotton by a Liverpool broker, then goes on to tell that about 1842:—

"A chemist in Calcutta received from the interior of India some wide-mouthed vessels enveloped in a fibrous substance, that attracted the attention of a rope manufacturer. It was jute; since largely cultivated in Bengal, and become the staple industry of Dundee and other towns in the north. It was in cutting the channel for a water-mill in California, in 1848, that a quick eye detected grains of gold in a quartzose rock, which for a time almost revolutionised the labour and the money markets. In 1850, an engineer in the same country was struck, while at church, with the very beautiful red colour used in the decorations of the interior. He inquired whence it came, and was told that it was an earthy powder, brought by the Indians of the mountains to their *padre*, a missionary. He investigated the source, and found cinnabar, the bisulphide of mercury. The opening of the mines of New Almaden was the consequence, and very soon after a fall in the price of quicksilver in Europe and America. During the opening out of a Pensylvanian salt spring, in 1859, the diggers struck a deposit of petroleum, which afterwards gave a name to the locality, Oil Creek, and a new article of commerce to the world; though the substance had been well known to the aborigines, and indeed to the ancients generally. In 1860, a shepherd in the employ of Mr. Hughes Hughes, of Wallaroo, South Australia, noticed that a *wombat*, an animal about the size of a badger, had, while enlarging its den, thrown up to the surface of the ground small pieces of greenish stone. These he collected and carried to his master, who recognised in them an ore of copper. The place was explored, a fine vein of that metal laid bare, and soon the mines of Wallaroo were added to the celebrated ones of Kapunda, found in 1844, and of Burra Burra, found in 1845. The smelting works of Wallaroo are now said to be approaching in magnitude to those of Swansea. More recently still, at the beginning of 1867, a farmer of Pniel, in the Republic of the Transvaal, South Africa, passing a neighbour's door, noticed a stone in the hand of a child, and asked the mother if she would sell it. 'Sell a pebble,' said she, 'No; but you are welcome to have it if you care to take it.' The farmer carried it to Cape Town and showed it to Dr. Anderson, who declared it to be a diamond. It was sent to the Paris Exhibition immediately, and was there valued at 12,500 francs, about £500. A tract of territory, hundreds of miles square, was explored, more precious stones extracted, and the land thereby raised in value enormously!"

Whenever contributions to our knowledge of raw materials are further required, accounts may be drawn, from the same source, of vegetable and animal oils, textile fibres, dyeing materials, caoutchoucs and gutta-perchas, gums and starches —with an elaborate description of timber trees, suitable for introduction into Europe under varying conditions of situation, soil, climate, &c.

The Dukes of Athole.

As illustrative of sagacious enterprise, the introduction of the larch into Scotland deserves mention here. Less than a century and a half ago the hills in the district of Dunkeld and Blair-Athol were barren, and scarcely worth a shilling an acre for any industrial purpose. James, the Duke of Athole of those days, brought over from the Tyrol, on the pommel of his saddle it is said, a few young larches, and planted them for ornamental purposes. Two of these now grow over his grave, noble monuments. Two thousand more were shortly introduced. It was an idea worthy of a great landed proprietor; for the trees could yield timber only for his posterity. The next Duke planted eleven thousand larches between 1764 and 1774; while the son of this latter, in the fifty-two years from 1774 to 1826, planted the enormous number of fourteen millions, some of them even on the summits of the mountains. It was calculated about the last-named date, says a writer in "Knight's Cyclopædia," that during the second half of the present century, all these will become successively magnificent timber trees, suitable for ship-building and large engineering operations; and that, if all went well, the planting would virtually be a creation of property to the amount of six or seven millions sterling.

Might not the experience of the Athol family be serviceable in Wales? But how are facts like these to become widely known, and how is their bearing on the industry of our country to be estimated, without an increase of commercial education in our land?

Materials for Industry.

One of the most interesting and important chapters of human economy and social progress is that of the discovery and gradual utilisation of different minerals, plants, and animal substances. The history of precious stones, and of others; of the precious metals and of inferior ones; of the coffee tree, the sugar cane, the vine, the hop, the tea shrub, the cotton plant, flax, the pepper plant, the clove tree, the nutmeg tree, and the tobacco plant; of sheep's wool, beavers' wool, camels' wool and camels' hair, goats' hair, silk, &c., and the influence that each has exercised on the advance of civilisation, is indeed curious and instructive. As proof that raw materials for new industries are well known, and only waiting development, let me here quote an eloquent passage from the record of the Exhibition of 1862, by Mr. R. Mallet, F.R.S, &c.:—

"The polished and glittering dark wedges of plumbago shown in the nave must have attracted the notice of most persons. Such slabs of material of the very highest and newest quality, from which the Fabre blacklead pencils, probably now the best in the world, are fabricated, are full of interest to all who remember when the Borrowdale mine, opened once a year to extract a few hundredsweight of blacklead, which sold for its own weight in silver, was the great supply for all Europe. But this Siberian deposit of graphite sinks to insignificance beside another Russian discovery of the same material, made only within the present year. Some who passed the cast-steel Russian gun of Aboukoff, probably remarked a pile of dusty black slabs upon the same bench, of some mineral easily mistaken at first for coal. This was the Russian blacklead, from a mass that has been discovered on the right bank of the great river Tungouska, in a country previously almost unknown, and in the depths of pine forests traversed by the wild Tunbusi. At the level of the water, torn and abraded by the ice coming down in winter, one continuous mass of graphite has already been traced, extending 3,000 yards or more in length, with an ascertained depth of 30 yards, and how much more below the water no one knows, nor how far the bed runs nearly horizontally in under the granitic mountain that, pine covered, rises steeply above it; here is mineral wealth; to what new uses may not this infusible material be hereafter put? What future powers and industries may lie slumbering in that black mass in its icy solitudes. Can it be that this indeed is the oldest trace of vegetable life that our earth has yet a record left of; the archaic remains of the world's earliest coal, whose carbon alone remains, the metamorphic witness of its ancient pedigree?"

Thus, the material wealth of the globe is seen to be scattered through every zone. The "Earth-gifts" of the great Creator and Disposer of all good seem to have been intended by Him to be sought for, that thus they might stimulate intelligence and reward industry. Even in the irregularity of their distribution, compensation has been found; for they have led to just exchanges, and thence to higher intercourse. It is worthy of remark, in passing, that one peculiar possession has often sufficed to raise a nation. The Chinese throve first by silk, the Hindoos by ivory, the Arabs by frankincense, the Dutch by fish, the Swedes by iron, &c.

Scientific Aids to Production.

Having occupied so much time on the application of my subject to new materials, little can be spared for aids to production. One proof, however, is as good as many, of the simple principle that intelligence is the greatest wealth producer at the smallest possible outlay, and is also the most liberal of all benefactors. I must be allowed to condense the following, from "Reports on the Paris Universal Exhibition," 1867, vol. vi., p. 186:—

"The founder of this establishment (Ransome and Co., Ipswich, 1785-1866), Robert Ransome, was the son of a schoolmaster at Wells, in the county of Norfolk, and was born in 1753. At an early period of his life he was apprenticed to an ironmonger, and in his leisure hours acquired some knowledge in the natural sciences, the study of which continued to be a source of much interest and enjoyment throughout his life. He attained considerable skill as an engraver and lapidary, being self-taught in these arts.

"His commencement in business on his own account was in a small ironmongery shop in Norwich; to it he added the business of casting small articles in brass by crucible. His skill and industry in this small business had excited the interest of one of the Gurneys—the leading firm in the banking interests in the county, and the influential promoters of every enterprise calculated to advance the commercial prosperity of its chief city. By Messrs. Gurney he was induced, and by their assistance enabled, to start a foundry for casting in iron. * * * His attention was very early turned to the adaptation of cast iron to the manufacture of the plough, and in 1785 he took out his first patent for tempering this metal for the ploughshare, in the hope of superseding the more expensive wrought-iron share at that time exclusively used.

"This invention met with but limited success, but it indicated the direction in which to seek a more perfect result; and, after experiments prosecuted with more or less success for 20 years, he, in 1806, took out his patent

for chilling the under edge of cast-iron ploughshares, leaving the upper portion of the metal comparatively soft, so that this, in its friction with the earth, should wear away from the harder skin formed by the chilling process on the surface underneath, and thus, on the same principle as maintains the sharp edge in the teeth of the squirrel and other rodentia, should always, in all the stages of its use, preserve a sharp cutting edge.

"In this happy though simple idea was found the solution of the problem; and at this day ploughshares made on this principle have almost entirely superseded the more expensive wrought-iron ploughshares, not only in England but on the Continent of Europe, throughout North America, and in all the agricultural colonies of the world where ploughs are used."

In many agricultural districts great drought prevails. A French ecclesiastic, l'Abbé Paramelle, who devoted himself to the discovery of small subterranean collections, or currents, of water, was so successful that, in the course of 34 years, he pointed out in France more than 10,000 sources of supply for this first element of fertility. His geological speculations were often erroneous, but the highest scientific authorities in Europe testified to the great practical value of his methods,* and the highest civic honours were bestowed upon him.

Guides to the Markets.

Let us now leave new materials and new aids to production, for the application of our subject to new markets and how to find them, aided by maps and geography. The good merchant has been described as one who "claspeth the islands to the Continent, and one country to another; whose trading makes England bear wine, and oil, and spices." But to do this he must know England's natural wealth as few can learn it. The industrial resources of Ireland have been admirably described by Dr. Kane; but I have not met with any similar work on the remainder of the United Kingdom. Professor Ramsay's physical geology contains chapters that are invaluable as they are beautiful, but I know no English treatise comparable to the "Géographie agricole, industrielle, commerciale et administrative de la France et de ses Colonies," by M. E. Levasseur, a series of manuals accompanied by a very convenient and elegant set of coloured maps of the rural and agricultural districts; of the districts distinguished for tillage or pasturage; of the districts of fruit tree and timber trees; of those for the breeding and rearing of domestic animals; of quarries of every kind; salt springs, thermal and mineral waters; of mines and mineral enterprises; of preparatory industries, mechanical and chemical; of textile industries; of diversified industries; of the canals, including those of Flanders and Provence; of railroads; of the French colonies, separately and also collectively; of military and maritime administration; of judicial administration; of the universities; of the ecclesiastical government.

Industrial Maps.

They are all produced in as cheap and attractive a form as possible, and cannot fail to affect beneficially the industrial career of the next generation. Of such industrial maps there is a dearth in England. The want has been so long felt that I deem it a duty to repeat it, and to quote a passage from the early writings of Thomas Sopwith, F.R.S., &c., an honoured member of our Society. Respecting a statistical and geological map of England he says:—

"In mining districts it has happened that a few yards only have intervened between the abandonment of works and immense stores of mineral wealth; and the relative position of mine-workings and mineral veins being often very imperfectly known, for want of accurate maps, it is impossible to calculate the loss which must inevitably have been incurred from this circumstance. Every day increases this evil, and with it increases the necessity for preserving exact records. . . . It would be a work of infinite advantage to the prosperity of mining countries to have meridian lines carefully set out at distances of one mile from each other, and tall posts or currochs placed on these meridian lines at every mile in length, the undulating surface of the country being truly reduced to a horizontal base so that these posts or stations should indicate squares of exactly one horizontal square mile. When rivers or other objects occur to prevent such posts being erected, the proper situation of them might be indicated by three or four marks placed at equal distances from them. The most important part of a district might be thus divided into square miles, and any one of these lines could at any time be continued in north, south, east, or west directions, so as to make a connection with other parts of the district."

A more recent special work by P. F. Bainier, late of the High School of Commerce, at Mulhouse, now of that in Marseilles, is well worthy of attention.

Economic Geography.

More than seventeen years ago, in addressing the teachers of a particular class at South Kensington, Professor Kinkel (now of Zurich) remarked:—"It is certainly a strange fact that Britain, although she rules over one fifth of the human race, and girds all oceans and continents with her dominions, has not established a chair for geography in any of her universities or larger colleges. . . . Notwithstanding her excellent Royal Geographical Society, England educationally ignores the world she governs."

Four years ago the leading journal said:—"The young Englishman is generally pretty well up to the geography of his own island; Switzerland, perhaps, parts of modern France, ancient Italy and Greece. But he knows next to nothing of any other country, because he cares for no other. Yet, without a wide and solid geographical basis for future development, it will be impossible for a merchant ever to carry in his head the commerce of the world, or to be prepared for any new information to be acted upon promptly."

Without dwelling on these authoritative statements, I wish to point out to members of all our chambers of commerce no less than to our future merchants, that while we are still delaying a museum for India and the Colonies, and doing very little for higher commercial education, the French are emulating the Germans in their study of the world we live in, its stores of wealth, and the ways about it. A Société de Géographie Commerciale has been formed at Paris, with branches at Bordeaux and Marseilles. "Questionnaires économiques" have been drawn up and widely circulated. The "Questionnaire sur le Commerce Maritime de Bordeaux," as published eighteen months ago, is a proof of the highest activity.

* See Paramelle, "Quellenkunde," mit einem Vorwort von B. Cotta. Freyberg, 1856.

One Geographical Society was established to foster the growth of the commercial enterprises of France in all parts of the world. It disseminates in France, and in French-speaking countries, information relating to commercial development; it initiates or favours expeditions that may lead to fresh enterprises; it studies the lines of communication already existing or to be formed between all countries; it indicates natural wealth, and illustrates manufacturing processes available for industry and commerce; it is interested in questions relating to colonisation, or to emigration, as well upon foreign soil as on French territory. It maintains correspondence with industrial and learned societies, and in general with all bodies and all individuals who may be able to throw light upon its labours. It can publish unedited works, have maps and illustrations engraved, and decree rewards. Another takes the initiative in founding in Paris itself a permanent museum, wherein by degrees shall be centralised all the most perfect specimens of all raw foreign products, unwrought materials of the animal, vegetable, and mineral kingdoms, coins, postage stamps, bank notes, telegraph codes, standards of value in exchange, &c. By the side of each specimen will be found a descriptive notice, indicating the country of production, the price, quantity, means of procuring; with the various expenses to be incurred in the working, obtaining, and transporting it to Europe; the modes of acquisition, whether by cash or by the barter of European merchandise. No one can fail to understand of what extreme importance such a permanent museum must be, where each merchant and manufacturer is sure to find at once the specimens that he wishes to study, with the explanatory notices facilitating fairly the acquisition he desires to make.

Statistics.

From economic geography generally, let us now turn to a particular branch of it—statistics; recollecting that "there are two purposes for which statisticians exist; two objects to be kept steadily in view by every collector of statistical information. The first is that of carefully gathering together facts and figures on every subject calculated to illustrate the position and prospects of 'society,' and so storing them up as to be accessible to all who may need the information they afford. The second, that of from time to time selecting from the stores so accumulated such particulars as should command attention, whether from their intrinsic importance or their relation to the subjects occupying the thoughts of those who may not have time or opportunity for the task of personal research—thus giving a present value to past labour, and in effect materially influencing the course of human thought and action in all that relates to the property of the nation or the welfare of its members."* Avoiding those of the Continent, and using our own chiefly, we will see how these help in opening up new markets at home and abroad. First, as to foreign trade. The census of 1871 was the earliest ever taken of the whole British Empire. Of nearly the whole of our Colonies and possessions it gives full particulars, not merely as to the areas, but as to the quality of the population, *i.e.*, ages of the people, occupations, civil condition, with occasionally climate and soil.

The reports of the Board of Trade at frequent intervals analyse the returns of business done with every country, give lists of foreign weights and measures with English equivalents, and publish many useful details. The national debts of every civilised State may also be compared, though not in the census tables. What more can be done? We shall see.

Use of Census Tables.

Let an inventor or producer of anything useful want to form an opinion for himself, independent of agents, as to how far he is likely to be successful in an effort to introduce his project into the home market. He will find in the census tables an amount of information that is not merely important but indispensable, because it exists nowhere else. It is not to be found in any commercial directory. And he cannot possibly be aware of it without previous instruction. If the supposed invention be comparatively low-priced, he may aim at disposing of a single specimen, say in each of one thousand towns; if high-priced, of a hundred towns. His first object will be to find these out. They are already found for him, and all particulars given. Observe Vol. IV., p. 38, area, inhabited houses, and population, in 1871, of 938 towns, and of the rural parts of each county. Population, in 1871, of those 938 towns, grouped according to magnitude. Population of those 938 towns in 1861 and in 1871. Area and population in 1871 of the 938 towns, and of the rest of the country. Distribution, that is localities, of the 938 towns in 1871. Again, Vol. IV., p. 35: population of 103 towns, containing upwards of 20,000 inhabitants in 1871, with their population at previous censuses within the same or the nearest corresponding limits. Population of the 103 large towns, and of the smaller towns and rural parts, from 1801-71. Or, further, let him consult a Table (41), England and Wales, showing the population of six classes of towns in 1861, and 1871.

In Table 108 is shown the distribution—in other words, the whereabouts—of quite a hundred of the leading occupations by which the wage-earning classes gain a livelihood. I take only one, the paper-makers, as an example:—In Holborn are found 133 males and 95 females; in Shoreditch the number are 90 males and 68 females; in Guildford, 89 males and 39 females; Bromley, 107 males 193 females; Dartford, 246 males, 376 females; Malling, 126 males, 99 females; Maidstone, 313 males, 453 females; Watford, 134 males, 78 females; Hemel Hempstead, 125 males, 75 females; Wycombe, 309 males, 145 females; Tiverton, 97 males, 93 females; Wells, 93 males, 38 females; Hayfield, 129 males, 62 females; Bolton, 235 males, 71 females; Bury, 408 males, 71 females; Salford, 95 males, 27 females; Blackburn, 226 males, 67 females; Keighley, 93 males, 28 females; Leeds, 104 males, 10 females; Durham, 112 males, 70 females. It follows, from the use of these Tables, that any man out of work may know in what direction to look to find out his fellow-craftsmen; and so, also, any man wishing to change his employment, may see at once where to go to meet with the one he wants.

Foreigners in the United Kingdom.

To dissipate jealousy as to the number and occu-

* Stephen Bourne, F.S.S.

pation of foreigners in the United Kingdom, I have drawn up the following table, referring to the commercial class especially, and the competition to which they are subjected. At foot the number of ur own countrymen resident abroad is shown, with the countries in which they are living. All these facts enter into and constitute an integral part of higher commercial education.

Compiled from Table XXVI., Vol. iii., *p.* lviii., 1871.—*Occupations and Country of Birth of Foreigners (males), being Natives of European States, enumerated in England and Wales. N.B.—These include all ages.*

Occupations.	Europe.	France.	Switzerland	Spain.	Portugal.	Italy.	Greece.	Turkey.	Austria.	Hungary.	Germany, including Prussia.	Belgium.	Holland.	Denmark.	Norway.	Sweden.	Russia.	Poland.
Merchant	2,301	301	92	76	26	84	96	163	62	20	1,084	28	105	36	15	23	62	28
Banker	71	22	3	2	..	1	1	4	1	..	29	3	1	2	..	1	1	..
Bank service........	39	5	3	..	..	..	1	..	..	..	22	..	3	1	1	..	1	2
Banker, Agent, Factor	820	137	29	19	3	52	23	18	43	5	287	24	60	29	24	15	18	34
Commercial Clerk ..	2,498	266	166	64	21	94	37	25	56	12	1,257	58	153	78	80	51	55	25
Commercial Traveller	416	50	19	9	..	20	2	5	15	3	125	13	34	8	2	9	22	80

The total of foreigners who are natives of European States, with their professions, are 89,829, divided as follows:—

1. Professional class, 10,161; 2. Domestic class, 24,186; 3. Commercial class, 19,909; 4. Agricultural class, 402; 5. Industrial class, 22,178; 6. Indefinite and non-productive class, 12,993. Their birth-places are—France, 17,906; Switzerland, 3,226; Spain, 1,484; Portugal, 459; Italy, 5,063; Greece, 603; Turkey, 528; Austria, 1,515; Hungary, 287; Germany, including Prussia, 32,823; Belgium, 2,535; Holland, 6,258; Denmark, 1,563; Norway, 4,041; Sweden, 1,969; Russia, 2,513; Poland, 7,056.

British Abroad.

The aggregate number of British-born subjects or natives of the United Kingdom residing in foreign countries, from which returns have been received, are 3,182,199, distributed as follows, on or about 3rd April, 1871:—France, 5,895; Switzerland, 2,297; Spain, 2,369; Portugal, 1,819; Italy, 5,344; Greece, 528; Turkey, including Egypt and Principalities, 3,275; Germany, 6,969; Austria, 1,528; Hungary and Provinces, 460; Belgium, 3,003; Holland, 1,077; Denmark, 269; Norway (*not given*); Sweden, 355; Russia, 2,432; Persia, 118; China, 949; Japan, 800; Siam, 130; Egypt (see Turkey); Morocco, 580; Algeria, 132; United States of America, 3,122,823; Mexico (*not given*); Central America (*not given*); Colombia, the Republic of the United States of, 500; Equador (*not given*); Peru, 79; Bolivia (*not given*); Hayti, 112; Chili, 2,614; Argentine Confederation, 10,533; Republic of Uruguay, 3,500; Venezuela (*not given*); Hawaiian Islands (*not given*).

European Races in the United States.

Inquiries have been made of me frequently about the foreigners in America—their numbers, occupations, religion, residence, &c. Such information cannot be afforded here, but I give a general analysis of the immigrants who landed on the American shores in the forty years ending with 1860, and I do so because they materially influence the markets of Europe from "home" associations; and, therefore, form an important element of commercial study. There came from different countries as follows:—Great Britain and Ireland, 2,750,874; France, 208,063; West Indies, 40,487; Sweden and Norway, 36,129; South America, 6,201; the Azores, 3,242; Sardinia, 2,030; Switzerland, 37,733; China, 41,443; Germany, 1,546,476, Holland, 21,579; Mexico, 17,766; Italy, 11,202; Belgium, 9,862; Denmark, 5,548; Portugal, 2,614; Poland, 1,659; Russia, 1,374; all other not stated, 318,140—total, 5,062,414.

For the fourteen years closing with June, 1869, there went to the United States, 2,918,213 persons; thus analysed:—British Isles, 1,340,824; British America, 129,449; Sweden and Norway, 98,581; Denmark, 16,692; France, 53,262; Switzerland, 28,189; Italy, 14,576; Hungary, 487; Azores, 4,588; Central America, 3,351; South America, 2,452; Germany (including Austria), 1,043,963; China, 78,817; Holland, 12,339; West Indies, 10,745; Spain, 11,463; Belgium, 10,167; Russia, 1,761; Poland, 2,209; Portugal, 2,090; all others, 52,098.

The following expression of American public opinion seems to me eminently deserving of the attention of young men:—

"Immigration is not an unmixed good. Very much depends on its quality. . . . We have always repelled, as adding insult to injury, every detected attempt of foreign princelings or municipalities to saddle us with the care and subsistence of their criminals, vagrants, or paupers. Doubtless these have, through collusion with sea captains, been thrown upon our charity by thousands, without eliciting even a remonstrance; but, whenever we have learned that a European prison or poorhouse has been emptied on our shores, we have resented it as a dastardly outrage. And, on the other hand, we have welcomed every immigrant, no matter how poor and illiterate, who brings hither an honest heart and two brown hands, as a positive and valued acquisition. While a stout ditcher or collier is justly thus valued, a thoroughly skilful and capable engineer or artificer is

still more precious. In winning Agassiz from Europe, we secured an acquisition of greater value than twenty day labourers; could we, at the same time, have won Liebig likewise, we should have been more proud of our acquisition than though it had been another Alaska or St. Thomas. Had it pleased God to send us Watt and Arkwright, and George Stephenson, in their early manhood, the gift would have been worth more to us than all Canada or Mexico. But we could not expect to draw men of high capacity hither, until we could proffer them congenial and remunerative employment."

Employers and Employed.

In the last place, as regards the bearing of our subject on the production of a better feeling between employers and employed. Industrial history teaches that differences have always existed between them, and have too frequently led, as in the Low Countries, long ago, to civil strife and ruin, unless these could be averted by higher education or emigration. The industrial reports of this day point to but one general conclusion, namely, that the industry of the future must and will be based upon cheapness of production; that wide-spread intelligence is the richest source of wealth; that every new invention or discovery inflicts suffering somewhere, but on the capitalist first. The study of social economy shows that a merchant's work does but complete the operative's; that the cost of getting a piece of timber into the market is greater than that of felling a tree; and that the expense of carrying coal or iron to the place of consumption is greater than that of raising the ore or of smelting it; also that, as in the corn trade, the public gain of low prices is often private loss to the dealer. Ordinary observation will satisfy any reasonable artisan that human strength is limited, but ingenuity is less so, and more capable of combination and multiplication of power; that his trade is becoming a matter of head-work rather than hand-work; hence the value of higher education to him; that it depends moreover on moral quite as much as on intellectual qualities, and must do so, so long as public and private credit have to be maintained; and where can they be neglected?

Strikes in Holland.

Beyond this, the reports of her Majesty's secretaries of embassy and legation for 1870 show philanthropy and patriotism successfully combining for a solution of the difficulties between employers and employed. In the spring of 1868 two strikes occurred in Holland, amongst the peat-cutters on the Belgian frontier, and amongst the skilled artisans of the Amsterdam ship-building yards. They were the first that occurred, and I trust the last.

Our representative, the Hon. T. J. Hovell-Thurlow, wrote as follows in his opening paragraph:—

"The exhibition which forms the subject of the present report was promoted by, and held under the superintendence of, the Society for the Encouragement of Manufactures and Mechanical Industry in the Netherlands. The avowed object of its promoters was to bring to the knowledge of the working classes such articles of household use, furniture, clothing, food, tools, implements, and objects of information or instruction, as combine usefulness with durability, so that the working classes of all countries might be enabled to improve their condition by judicious investment of their wages. A further object which the promoters of this undertaking had at heart was, by arriving at a full knowledge of the utmost purchasing power of the daily, weekly, monthly, or yearly earnings of every class of labourer or artisan, to discover—1st, how such earnings are commensurate with the wants it is their duty to supply; and 2ndly, how far such earnings, if not commensurate, should consequently be raised, without interfering with the natural laws which govern capital and labour, supply and demand, and overtaxing the rich producer for the benefit of the poor consumer. 'The labourer is worthy of his hire' is the motto that the Netherlands International Exhibition of 1869 sought to uphold; and it further undertook to lay down, by tabling facts and prices, and to place it in the power of all to ascertain the hire that labour of all kinds should be entitled to command, so as to combine the possibility of health, contentment, and the attainment of intellectual enjoyments among the working classes of society, with a reasonable profit margin to the employer. The limits of what would be termed legitimate or judicious strikes would thus, it was hoped, be more clearly defined, and the world at large might, perchance, be saved the pain, the evil, the waste, the crime, entailed by the repetition of hopeless, injudicious strikes, in cases where the employer of labour is unable to offer better terms, and tho hands have taxed themselves by deductions from their scanty wages to do what? to enable them to remain idle for certain weeks or months, and after being compelled to sell furniture, incur debts, and render their position more intolerable than before—to return, one morning, with emaciated bodies, and heavy, discontented hearts, to the factory or mill."

The Bloom of Industry.

Further on he remarks, concerning some of the exhibiting associations:—

"The only society I have been able to discover that in its statutes deal openly with wages and hours of labour, is the Arnheim Association, entitled 'Handwerksbloei' ('Bloom of Industry'). Its object is to promote the interest of the workgiver and the workmen, by reducing the hours of labour for efficiency of workmanship, retaining uniformity of wage. Its members are employers of labour in all trades, who are briefly styled the 'baas' or 'boss,' a word which the original Dutch settlers of Hoboken (New York) have permanently engrafted on the American vocabulary. In and around the rich and thickly peopled province of Arnheim, this society has enrolled well-nigh every workshop and factory under its banner, to the great satisfaction of the workmen themselves, who, on attaining a certain state of proficiency, find their hours of labour curtailed to an extent representing in the aggregate one day in eight, or even two hours in the day, the former wages being retained. The workmen of these masters are furnished with livrets, for which they pay five cents (1d.), and in which their proficiency is noted, and their proficiency is noted, and their promotion to shorter hours recorded. They are divided into three classes of efficiency. A master is bound to give up the livret to a workman quitting his service, and the members of the association also bind themselves not to re-engage a man (without a general inquiry into his case) who has taken service with a master or 'boss' not belonging to their association."

In Baron Mackay's letter to the Minister of the Home Department, transmitting the final list of awards, it is mentioned that the jury reports will substantiate his assertion that the Dutch consumer has profited by the Amsterdam Exhibition (for instance the carpenter had learned to distinguish Sheffield made tools from foreign imitations). He adds:—

"I cannot abstain from recommending all who may at the first blush of the Working Man's Exhibition of 1869, be

disappointed that no miracle had been wrought, that stones have not been converted into bread, nor the barren rock made to run with living water, to delay their criticism for awhile, and await the interesting contributions to social science which will ultimately spring from this as yet pent-up source."

Summary.

And now it is time to close these remarks, for such they have unavoidably been, rather than a process of reasoning. Many important topics are left untouched, but if those which have been dwelt upon appear deserving of consideration, be sure that the remainder are not less so. I shall be glad to find that my small part has led to a study of the whole of the "Programme of Commercial Knowledge," as prepared by the Council of this Society many years ago.*

Had it been practicable to attempt more within an hour, it would have been right to point to industry excited all over the globe; to the daily ebb and flow of exports and imports; to the influx of produce and evidence of good feeling from all countries; and to refer to the confidence in each other maintained among mercantile men in different parts of the world. Few merchants ever see the commodities they buy or sell, except by sample; and fewer still ever see, except on paper, the money that pays for them. It literally comes and goes, to and from all parts of the earth, almost unquestioned.

It may be objected that I have taken only a utilitarian view of the subject; this, however, is one that concerns our statesmen and legislators. There is high authority for saying that: "No hungry or houseless people ever were, or ever will be an intelligent or a moral one. The charities of Christian life are often straitened, because the means of benevolence fall short of the requirements."

To a student of history there is a charm in contemplating the prospects of commerce. A merchant in his counting-house with telegraph and telephone at command, calls to his broker on one side of the globe, and his warehouseman on the other. If his orders are misinterpreted, he finds means of redress; if his cargoes are intercepted, Parliament interferes, or Congress interposes. The maritime law of nations foreshadows international law, this again international security, and ultimately, we trust, international peace and universal progress.

Our Neighbours and Ourselves.

The nations nearest us have instituted a laudable but formidable competition in promoting national well-being. They advance by different roads. One tries parental care and supervision; another leaves the people to their own unfettered but unassisted resources. To some again it seems that local position and circumstances should dominate the question. Assuredly, however, help in educational matters has never been lost. It would be easy to prove that the rapid rate of industrial development in continental countries, and particularly in America,* is a direct consequence of their systems of national instruction. "Practical progress under the influence of competition becomes a race; and in a race time wins. To be indifferent whether certain points of practical information will be known sooner or later, is like being indifferent whether one goes to a certain destination by rail or by road."

Less than half a century ago, the secretary of the Society for the Diffusion of Useful Knowledge, was journeying outside the north mail one night, talking with a fellow-traveller on the prospects of the society, when the driver suddenly interrupted the conversation—"Pshaw!" cried he "Who wants your confusion of useful knowledge? What is the good of it? Will it mend the roads? Will it bring more passengers and parcels? That is what I want to know!"

Now, since then, travelling has been accelerated; passengers and parcels have multiplied; new roads have been constructed, and diffusion of useful knowledge has had a great deal to do with the progress made, but neither the driver nor the coach have kept pace with the times. "In fact," said Lord Brougham, who used to tell the story, "both have disappeared."

Young men who may think of going abroad, and thus of competing with foreign clerks, correspondents, salesmen, &c., are requested to read carefully the following:—

Appendix.

[Translated from the "Questionnaire" of the Society of Commercial Geography at Bordeaux.]

After many inquiries "At sea," "In the roadsteads," "In Port," come a list of "Observations relative to Commercial Geography."

I.—*Exportation and Exportable Products.*

What are the mineral products of the country? Where are the mines and quarries situated? At what distance from the port? By whom and how are these mines or quarries worked? What is the mode of working them? What are the ways of communication and means of transport between the works and the port? Are there any unworked beds? Could these be worked with advantage? What are the agricultural riches of the country? What vegetable products are available in the port? What products are not objects of much commercial importance? Could any extension be given to such commerce? What European plants are acclimatised or capable of becoming so in the country? What native plants could be acclimatised amongst us? What animals, wild or domesticated, are found in the country? Or what use are they? What resources do they afford to commerce? What European animals are acclimatised, of capable of becoming so, in the country? What are the native animals that could be acclimatised in Europe? What are the industries of the country? What industrial products are exported from the port or the country? To what destination? By what route? Through what medium? What is the price of these products on the spot? Request; to bring back specimens of the mineral,

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* Allow me to recommend students to apply to the Secretary of the Society of Arts for a copy of the Society's Programme of Examinations in Commercial knowledge, containing also those on the Technology of Arts and Manufactures, with the prizes offered, and the payments to teachers. A few young men in any town might as a body join the "Institutions in Union with the Society of Arts."—J. Y.

* Prior to his famous "Educational Tour in Europe," Horace Mann, Mass. U.S., had instituted a long series of inquiries into the effect of education upon the worldly fortunes of men; its influence upon property, upon human comfort, and competence; upon the material interests of individuals and communities everywhere. The fruits of that report published in 1842, are visable to-day in the industrial character of American instruction; in the ingenuity of her artisans; in the ramifications of their enterprise; in the progress of their agriculture and manufactures.

agricultural, and industrial products of the country, marking carefully on the tickets the places whence the products come, the usual names in the country, and the value on the spot.

II.—*Importation and Products that may be Imported.*

What are the industrial products most in demand among the inhabitants? From what nation, from what manufacturing centre, through what medium are they received? Does France send her produce into the country; do the inhabitants prefer French goods or similar, but foreign produce? Say why? What are the prices of these products? What is the quality of them? For what use are they designed? N.B.—It might be advantageous to our manufacturers to have specimens of those European goods which are particularly esteemed in the country, their price in the market, and the duties to which they are liable, carefully noted.

A copy of the above might be useful perhaps in the cabins and forecastles of emigrant ships, passenger ships, and all mail steamers carrying the British flag. It might also, with advantage, be posted up in our consulates abroad.

[Translated from the "Gewerbliches Fragenbuch, von Dr. Karl Karmarsch."]

The Work of a Writer or Clerk.

1. What qualities are the most important in every written composition?

2. What are the advantages of brevity in a composition?

3. What qualities must not suffer through brevity?

4. In a composition how may we most easily attain to that clearness and that connection of the matter which are indispensable?

5. In a business letter where is the "datum" or declaration of place, day of the month, and year to be set; why is that particular place the fittest?

6. In letters of a business character, why is it not enough to write a recipient's address, or name and place of abode, merely on the outside of the blank second page, or on the envelope? and which is the best place for a repetition of the address in the letter itself?

7. What must be done in order that the exact contents of all the important documents which are put out of hand may be referred to at any future time?

8. In what way must the keeping of the substance or summary of each document be contrived so as to avoid unnecessary loss of time in reference?

9. In what way are letters or other papers that must be kept, most suitably arranged, in order that each separate document may be found again with the least expenditure of time?

10. What is the object of keeping a letter-copy book? What is the advantage of a press-copy book? Describe the arrangement of one, and say how it must be managed that it may have validity in a court of law?

11. Why must every business letter that has to be sent away be transferred to the copy-book?

12. What is to be thought of the proceedings of those who destroy letters, accounts, acknowledgments, receipts, &c., either immediately or after a short time?

13. Up to what period, at least, should every document of such a description be kept? What does the Commercial Statute-book determine, as regards the time for keeping business papers?

14. But for what various reasons is it useful to preserve the above-named papers, even long beyond this indispensable period?

15. What is there to notice at the top of every letter received, at once on receiving it, and afterwards on answering it? Wherein consists the use of this notice?

16. What rule must be adopted as inviolable, if we would be sure that no letter or other paper can be misplaced?

17. By what means may we be certain never to fall into disagreeable arrears with correspondence?

18. Is it advisable to send off letters by private opportunity, or as enclosures? For what reason?

19. In the language of the Post-office, what does "simple" letter mean? What is the greatest weight allowed for letters of double postage?

20. What is the cost of postage for a single letter throughout Germany?

21. By how much is the postage increased for every unpaid letter?

22. What has always to be observed as regards the payment of postage on letters addressed to officials?

23. What is understood by posting per cross-band and strip-band?

24. What papers are they which solely may be sent through the post by cross-band and strip-band?

25. What may papers under cross-band and strip-band not contain?

26. What sort of things, then, may a man in business conveniently transmit by cross-band or strip-band?

27. How must the cross-band or strip-band be arranged to ensure safety, and comply with the legal requirements of the Post-office?

28. How is the postage for cross-band missives throughout Germany calculated?

29. May cross-band missives be dispatched prepaid or unpaid at will?

30. What injury would be done to the recipient of a cross-band missive were this not prepaid according to its full weight?

31. What regulations and favourable conditions exist as regards the transmission of patterns by post?

32. How may postage-stamps be used occasionally in business for other purposes than for the payment of letters?

33. What different ways are there for the settlement of payments through the Post-office?

34. What is to be observed with regard to the packing up of gold and silver coins or paper money?

35. To what extent is payment by Post-office order practicable?

36. What must we mind on declaring the value of remittances of money?

37. Is the sending away of undeclared paper money in letters advisable? Why so?

38. In what cases and in what way may claims be settled through prepayment by post? In such cases, what must be specified in the address of the letter?

29. Wherein consists the real and necessary purport of a bill of lading?

40. What is understood by the term drawback (Nachnahme) in freight or in transport by railway?

41. What expenses are regularly covered by drawback?

42. Under what circumstances may even the cost of the goods come under drawback?

43. Why is it absolutely necessary, when answering a letter, to have that letter lying before us?

44. What might only too easily happen were a man to attempt answering a letter from memory only?

45. If a letter that has to be answered contains several inquiries, in what order are the answers to be given most serviceably, and why so?

46. What must be borne in mind above everything else in the commencement of a reply to a letter? Why is this necessary?

47. In a letter, by which the receipt of gold, bills, or goods is to be acknowledged, what must, above everything else, be definitely and accurately expressed?

48. In a letter by which the receipt of goods is acknowledged, what further must be said about those goods with regard to unconditional or conditional credit for the amount of them? In what cases is the latter advisable?

49. When are casual deficiences in goods received to be mentioned to the sender of them?

50. Of what must a letter, which encloses money, bills, or papers of any kind, contain the most particular statement?

51. What is the proper time for giving notice of the despatch of goods to the person for whom they are intended; and what should be appended to the letter?

52. What must an acknowledgement of the receipt of money or of goods contain as the most important point?

53. In what way must amounts of money be written upon acknowledgements or receipts in order to prevent, as far as possible, any fraudulent alteration?

54. How would you secure yourself by the mode of expression adopted in a receipt for money or goods, which come to you (otherwise than through the post) packed up or concealed from view; but for which you must immediately write an acknowledgement before you have had time to investigate the accuracy of the contents as given in?

55. If in the payment of an account a separate receipt has to be given, that is one not written upon the account itself, what must be specified on that receipt, supposing the sum received is only a deduction from the amount, or a remainder after previous payment of a deduction? In such a case, how would you refer to such a separate receipt, when you write a receipt in full upon the account itself?

56. What must be expressed in a receipt for interest on a debt?

57. What specifications must not be neglected in a receipt for house rent?

58. In the drawing out of an account, what must be contained in the superscription?

59. Why is it dangerous to write at the bottom of an account the name of him who draws out the account?

60. How will you arrange so that an account which has been drawn out shall be quickly referred to in the account-book?

61. In accounts, what should be prefixed to each separate item of contents.

62. In what form is the receipt of the amount to be certified upon an account when it is paid? What must be observed particularly in receipting simply an account for goods, in order to make impossible any subsequent falsification, as to higher amount, or as to extension of contents?

63. How is this certification to be expressed if by chance a deduction has to be allowed, or if only a partial payment has to be acknowledged?

64. On the delivery of goods for credit (*auf Borg*) is any written document to be given with them, and what? Is it advisable to make any exception to this rule on account of the smallness of the amount?

65. In every case what must take place before an account is allowed to go out of hand, in order to be sure that it is free from error?

66. Many have a habit of sending in already receipted accounts for which no money has yet been received. What are the disagreeable consequences, and the danger of this custom, and by what precaution may the danger be averted?

67. What essential points must a claim for debt comprise?

68. According to what rules are actions for debt to be brought, and if necessary further proceedings to be taken?

69. Before what officials are actions for debt to be carried (in Wurttemberg) and to what amount in dispute, are the authorities in the place of abode of the defendant, competent to decide?

70. What principle must be considered inviolable in the drawing out of certificates of character?

71. What must a certificate of character for a servant, a journeyman, a labourer, necessarily comprise?

72. In the drawing out of written agreements of every kind what must be carefully guarded against? In the comprehension (or interpretation) of agreements about important affairs, or affairs not perfectly plain, why is the help of a legal man advisable?

[Translated from the "Gewerbliches Fragenbuch," von Dr. Karl Karmarsch.]

Accountant's Work.

1. What is the unit of the metrical measure of length?

2. How does the subdivision and multiplication of it take place?

3. What is the 10th, 100th, 1,000th part of that unit, and what is the 10th, 100th, and 1,000th multiple of it?

4. Which of these measures of length is used as the road measure?

5. What is the unit of the metrical measure of surface? How is it connected with the measure of length? What are the subdivisions and the multiples of it?

6. Which of these superficial measures are used as land or field measure?

7. What are the metrical cubic measures, and what are they called?

8. How many cubic centimètres does a cubic mètre contain? And how many cubic millimètres does a cubic centimètre contain?

9. What is the unit of the metrical measure of concavity or capacity? How many cubic centimètres does it contain? What connection has it with the measure of length? What magnitude, and what name, have its subdivisions and multiples?

10. What is the unit fcr the measure of wood?

11. What is the unit of metrical weight? What magnitude, and what name, have its subdivisions and multiples?

12. What proportion does the kilogramme bear to the German zollpfund?

13. What connection is there between the metrical weight and the metrical measure of concavity or capacity?

14. How was the Wurttemberg foot measure, which we find used in the books and writings of a former period, divided? What multiplies of it were customary?

15. How large was the Wurttemberg foot in parts of metrical measure?

16. How large is the mètre in Wurttemberg, feet and inches?

17. How large is the Wurttemberg ell expressed in feet and inches? And how large in metrical measure?

18. How would you express in metrical square measure the size of a room given as 298 Wurttemberg feet square?

19. A beam is 12·4 mètres long, 0·23 mètres broad and thick, what are its cubic contents?

20. There is a block of stone 1·02 mètres long, 0·65 mètres broad, and 0·32 mètres high, what are its cubic contents?

21. A road 10 mètres in breadth and 17 kilomètres in length is to be raised 0·35 of a mètre on the average; how many cubic mètres of material will be required for the purpose?

22. A block of marble, which has a specific gravity of 2·5, weighs 1,866 kilomètres; what are its cubic contents?

23. An empty cask weighs 50 kilogrammes, and when filled with water 400 kilogrammes; estimate its contents?

24. A cask of three hectolitre size, filled with wine of the specific gravity of 0·95, weighs 350 kilogrammes; how heavy is the empty cask, and how much would it weigh filled with water?

25. From an earthern oil-vessel which when full weighed 570 kilogrammes, oil had escaped so that it now weighed only 490 kilogrammes, what will the loss amount to by measure if the oil has a specific gravity of 0·82?

26. On one square mètre of white iron plate let us suppose that there are (both sides taken together) 425 grammes of tin. How much tin lies on a roof for the

covering of which 1,250 plates of such tin, each 0·35 mètres long and 0·25 mètres broad, were used? How thick must we reckon the tin coating to be, and what space would the collected tin alone take up if it have the specific gravity of 7·02?

27. What are the Wurttemberg coins in silver, silver small coin, and copper small coin?

28 According to what standard of coinage are the half-guilder pieces and all the larger silver ones coined?

29. How many guilders of such silver money must a man have together to obtain from them a kilogramme of fine silver?

30. Why does a guilder made up from small silver coins contain a less amount of real silver than does a guilder piece, notwithstanding that this latter is less in weight?

31. In what other German States does the standard of coinage agree with the Wurttemberg?

32. Why do the Wurttemberg and other German thalers bear the inscription Union thalers?

33. What is understood by the thaler standard?

34. Where is the thaler standard in use?

35. How is the thaler divided in the states of the thaler standard?

36. How many thalers does a kilogramme of fine silver contain?

37. What proportion is there between thalers and South German guilders in the smallest whole numbers?

38. What is understood by Austrian standard?

39. How many Austrian guilder pieces taken together contain one kilogramme of fine silver?

40. How is the Austrian guilder subdivided?

41. What is the proportion between Austrian and South German guilders in the smallest whole numbers?

42. How much is the Austrian guilder worth in South German money?

43. Is the Dutch guilder equal to the South German in intrinsic value?

44. What is the alloy of copper in the Union thalers and in the remaining South German silver coins, with exception of the small coinage?

45. What is the meaning of the inscription on most of the older thalers—"14 one mark fine?"

46. What is the value of one dekagramme in Union thalers, or in $3\frac{1}{2}$, 2, 1, $\frac{1}{2}$ South German guilder pieces?

47. From one kilogramme of fine silver sixty German thaler pieces are coined, each three marks in value; in the gold 20-mark pieces the value of one kilogramme of fine gold is reckoned $15\frac{1}{2}$ times as high as that of a kilogramme of fine silver, and nine parts of gold are alloyed with one part of copper. From this, how high must the weight of a 20-mark piece be estimated in grains?

48. What is the value of twenty-five 20-mark pieces in South German money?

49. How many marks are 1,492 South German guilders worth?

50. According to what money standards do the French, Swiss, and Belgians reckon?

51. How high is the French, Swiss, Belgian, and Italian franc reckoned and accepted amongst us?

52. What is understood by the course of exchange in currencies?

53. What is meant, when it is said that the course of a certain kind of foreign coin stands at par, above par, or below par?

54. Whence comes it that gold coins have a variable, and often fluctuating course? What is the cause that the German 10 and 20-mark-pieces make an exception from this (in their circulation in Germany)?

55. Why is the course of foreign silver coinage so uniform, or so little variable?

56. What exchange is it whose course is commonly adopted as guide in Wurttemberg?

57. In what way may payments be effected, without the transfer of bullion or coin?

58. What is meant by a draft?

59. What is understood by coupons, and what must be observed when these are taken in payment?

60. What is a bill of exchange? Wherein consists its essential features and its legal claims?

61. Wherein lies the difference between a draft and a bill, between a bill and an acknowledgment?

62. Why is it advisable for a man, in a small way of business, to draw bills on himself, or to suffer others to draw bills upon him, only with extreme caution?

63. What precaution must be observed in the taking of a stranger's bill instead of payment, to prevent loss?

64. Wherein consists the difference between a protected or own bill, and a bill drawn upon you (a draft)?

65. What is meant by drawing on, and by remitting?

66. What is a remittance?

67. Which person is named "drawer," which "drawee," which "remitter"?

68. What do the terms "sole bill," "first," "second," of exchange mean?

69. What is the meaning of the expression "To the order of" in a bill? In what case does a man sometimes draw it to his own order?

70. What is the meaning of the expression in bills "Value received" or "Value in account"?

71. What is indorsing a bill? How is indorsement effected? Where is the indorsement to be written?

72. What is the meaning of indorsement "in blanco"?

73. Which persons are called the indorsers or giranten of a bill? In what relation of responsibility does one indorser stand to the one next succeeding him?

74. What is meant by expiring, the day of expiring, applied to a bill?

75. What are called short bills; what long ones?

76. What is the meaning of "At sight" on a bill or draft?

77. When a bill has been drawn at so much time after date, how are the days that it still has to run reckoned?

78. If a man draw a bill on a creditor or on a business connection, what ought also to be done at the same time to the person drawn upon? What ought a letter of advice to contain? What meaning have the words occurring at the end of bills or drafts "according to advice," or "without advice," or "with or without advice"?

79. What is the acceptance of a bill?

80. What should a man do immediately after taking in payment a bill payable at his place of abode but not yet accepted?

81. In what form is an acceptance expressed upon a bill?

82. What injury threatens the holder of a bill who fails to present it for payment, properly, on the day when it falls due?

83. What is to be done when the acceptance of a bill, or payment of a bill already accepted, is refused?

84. Can, and ought, according to circumstances, a protest to be made twice about one and the same bill? And on what account?

85. May a drawee be induced to allow a bill to be protested even when he acknowledges his indebtedness to the drawer?

86. By whom must the protest of a bill be taken up? After performance of the protest what is there further to observe?

87. What means and rights are befitting the possessor of a protested bill, as regards redress?

88. Why in the sending away of bills is a declaration of value not necessary on the letter?

89. What is meant by course of exchange?

90. In newspapers devoted to exchange business what is meant by the expressions "paper" and "money"?

91. What is to be understood by the gross weight of goods?

92. What is "tare"?

93. What is "nett" weight?

94. What is deduction or allowance? How is it decided and reckoned?
95. What is to be understood by discount in the payment of cash for goods?
96. What is "commission"? How is it calculated?
97. What is "brokerage"?
98. What is to be understood by "charges"?
99. What is the meaning of the expression "for account"?
100. What is the meaning of "prompt" payment?
101. What is meant in price current by "six months' term" and without liability?
102. What is meant in a price-list by "For account with $1\frac{1}{2}$ p.c. discount, or three months' term"?
103. What is meant by discounting a bill?
104. What is understood by bill discounting? How is it calculated?
105. What is understood by the word "Agio"?
106. Can you furnish any example of "Agio"?
107. What are the advantages to a man in business of buying his materials in large quantities?
108. What must be observed, however, respecting payment for these purchases, that a man may not fall unawares into any very disagreeable embarrassment?
109. What is the advantage of paying cash as far as possible for purchases?
110. What is understood by "valuation" of finished goods?
111. Why is a careful and exact valuation indispensable to success in business?
112. What are the three principal divisions into which all the items of a valuation severally fall?
113. What belongs to "cost of materials" beyond the price paid for them?
114. How are the waste cuttings, shreds, or fragments, that are still of some value, to be brought into account?
115. What does "cost of labour" comprise?
116. In what way are wages to be calculaled?
117. How is a suitable allowance to be made for wear and tear of tools, &c., during the course of the year?
118. In what way, and to what amount, must the deterioration of machinery be allowed for?
119. Under the head of "general costs," what must be comprised and carried to acconnt?
120. How are house or dwelling expenses to be estimated by a man who works in a hired house, and how by one who works in a house of his own?
121. In carrying on a business what things have to be taken into account as accessories, *e.g.*, writing materials, paper for packing, &c.?
122. How are taxes taken into account?
123. To what extent must the expenses of fire insurance, waste through spoiled work, loss through bad debts, loss through fall in exchange of bills or specie, be carried to account?
124. What must be done in the valuation, if the business necessitates journeys occasionally?
125. How must the valuation be managed so that interest on everything kept in stock, on current expenses, and on provision for coming expenditure, may not be lost?
126. Is this interest to be taken into account only when a man works with borrowed capital, for which he must pay interest in cash?
127. How is the loss of interest through the giving of long credit to be estimated?
128. How much is to be added as necessary profit?
129. In a valuation, what mode of reckoning must be applied to those items of value which, from their nature, do not admit of exact separate estimate?
130. How far can or must the price-lists of rivals in trade furnish a guide for one's own price-list?
131. To what must a tradesman immediately give heed, if he sees that the majority of his rivals offer lower prices than he at the time can afford?
132. At what must the tradesman aim in the maintenance of his business, when he sees himself compelled by competition to put up with a smaller profit?
133. Under what circumstances must the price of an article that was made some time previously, or that has been frequently made, be reckoned afresh?
134. How are expenses that cannot be known beforehand to be sought out, or allowed for?
135. What is indispensable to a tradesman, in order that he may have access to all particulars of his business during the past?
136. What is an estimate of costs?
137. Wherein does an estimate differ from a valuation of finished goods?
138. In an estimate may the exact computation be omitted, because in the amount given only the final result of the calculation—namely, the price to be fixed —is written down without further proof?
139. How ought we to proceed with the estimate of price in larger works, which must be computed in their several parts, as it is not customary to add here apart the so-called general charges?
140. How would you proceed in such a case with the so-called general charges?
141. Why is it useful, even if not required, to mention in an account for goods delivered the most important items out of which the price of the whole has been made up?
142. In what way is the so frequent, yet so disagreeable, result to be avoided—namely, that after completion of a piece of work the account for it amounts to more than the estimate probably given in before?
143. How is the difference to be dealt with?
144. How does a prudent business man proceed when an account is paid to him in his own house by a customer; that is, in what order does he perform the three things thereby necessary?
145. If the payment be made in the house of the customer, what must be carried out as quickly as possible?
146. How is the very disagreeable mistake of charging a second time articles already paid for to be avoided?
147. What is the Statute of Limitation? What legal regulations exist with regard to the limitation of industrial claims? What has a man of business to bear in mind in this matter to protect himself from loss?

DISCUSSION.

Mr. Hale had been much pleased with the paper, but thought it would be well if readers of papers would not attempt to go over so much ground that it was almost impossible to get through it. He understood the main point to be that England is behind other countries in educational matters, and he feared this was true. Intelligence, perseverance, and industry were the three great requisites to success all over the world. Most people had to learn a great deal after leaving school, but he thought it would have been well if details had been given as to hours of school in different countries. He had been much struck with the attempts made abroad to instil into the minds of the population a practical knowledge of men and things, and he thought it would be an advantage to this country if successful men of business were employed as school inspectors instead of merely University men.

Mr. Christian Mast confessed to being somewhat disappointed with the paper, especially as he had listened with a great deal of pleasure on a former occasion to Dr. Yeats. A great deal had been said about commercial matters, but the great point as to what commercial education should be had been, it seemed, omitted. As the conductor of a school he felt disappointed, although others whose interest lay in a different direction might have derived more benefit. He had hoped to have Dr. Yeats' advice as to how English schools should be arranged differently to what they are at present, with any hints as to the general mode of teaching in this country, and where commercial education is defective. A short sketch had been given of the German system of teach-

ing, but that could not be followed here without going to Government for a new Bill. The most teachers could do was to endeavour to act on public opinion. He conducted a school, and had a large number of pupils, some of whom were entering into commercial life, and he had proposed to open special classes for commercial education, and offered to engage extra teachers, charging a small extra fee for this superior commercial education; but he found that parents were quite unprepared to pay for it, and not a pupil came forward. It was quite true, as Dr. Yeats had pointed out, that the system of teaching modern languages on the Continent was superior. That, again, depended in a great measure on the appreciation it met with in this country. As soon as this branch of knowledge had been properly valued, the better methods of teaching would be understood. Jacatot's name had been mentioned, but he could assure Dr. Yeats that his plans were quite gone out of date on the Continent. It was also a mistake to suppose that Chinese, Japanese, and other Oriental languages were taught on the Continent with a view to promoting commerce. Trade could be very successfully carried on with those countries without a knowledge of the languages, and they were taught more for the sake of diplomatists than commercial men. Dr. Yeats had referred to the fact that the Germans beat Englishmen in some cases, owing to their superior culture. But what was the cause of this culture? On that point he would read a short quotation from Gustave Freitag, which he had previously read at the College of Preceptors, in which that well-known author attributed German culture to the study of Latin and Greek. From his own experience he might state that this was quite borne out, and he believed that where one young man was specially talented in arithmetic, but had not received a classical education, and another had done so without any special aptitude for arithmetic, the latter would in the end attain a higher position and make a far better commercial man. He would be able to look beyond the four walls of his office, and would by-and-bye become the sort of man best fitted for the work.

Mr. James Price thought the paper a most able and elaborate one, and that the remarks of the last speaker were quite uncalled for. The subject was not general education, in which, no doubt, great improvement had been made, but higher commercial training, for which nothing had yet been done. Mr. Mast said people might make fortunes in China without any particular education; and so they did here and in other countries, and all credit to them for it. But that did not bear on the special subject before them, neither did the remarks on the value of learning Latin. No doubt it had its advantages as a part of a classical education, but it had no bearing on the point under discussion, which was one of vital importance to the whole community. England had reached its high position among the nations principally owing to its commercial success, and, therefore, everything possible should be done to ensure the continuance of that mercantile pre-eminence. Up to the present time there was no doubt that we were in many points deficient as compared with other nations, especially America, France, and Germany. That was shown by the number of French and Germans who came to this country; the French were more artistically educated than the English, owing to the deficiency here of such schools as it was now contended should be established. In these schools in France boys were specially trained in connection with every branch of manufacture and commerce, and the consequence was that their special manufactures were being introduced into this country, especially since the treaty of commerce. Again, many Germans came over here and obtained high positions as correspondents, owing to their superior education in languages, &c. It was impossible, therefore, for England to compete in many things with France, Belgium, and Germany, though, owing to our native energy, we had been able hitherto to take the lead in commerce, and we trusted we should continue to do so. As other countries, however, were now paying so much attention to special training for specific purposes, it behoved England to do the same. For all the professions there was a special training leading up to them; if not, what would become of them? The same with regard to music and art; but commerce was a thousand times more important than any of these, for the national independence and even existence depended upon it. He trusted, therefore, that this paper would receive the most favourable consideration and support.

Mr. William Botly agreed with the last speaker, for all must have seen how the Germans and French were elbowing out the young men of our own country. Dr. Yeats had referred to home culture, and he considered that of the very highest importance. There was too much frivolity in many homes, more than was found in Germany and Switzerland, and where that was the case, there could not be that serious culture which was necessary to a high commercial education. Too much attention could not be paid to special training for the various branches of commerce; but, after all, moral culture, which had also been referred to, was of supreme importance.

Mr. Pullar asked how Dr. Yeats expected that a higher education, either of workmen or masters, would in any way alter the relations of employers and employed. It seemed to him that, whatever education you gave, it would make no practical difference at all either to the terrible stress, on the one hand, of being asked to work for the very lowest wages, and, on the other, of being obliged to ask this, in order that the employer might make a living profit. The root of the whole evil was excessive competition. It was so severe on the master that he was obliged to press his workers down to the lowest living point, and then they were forced to enter into trade combinations in order to resist the pressure on the part of the employers. The masters on their side had the same pressure amongst themselves, and nations had the same pressure as individual employers, because they competed with one another. Whatever education might do, there was the great fact of excessive competition to deal with, which in the end became self-destructive when unrestricted, though it was often limited by agencies which were not always recognised. He understood Dr. Yeats to say that when the labourers in Holland found they could not live on the wages offered them, the Government got up an exhibition, but he failed to see how that exhibition raised the wages or diminished the necessities of the workers. Competition was not an end in itself, though many seemed to consider it so; its real object was to find out in what parts of the world certain substances could be most favourably produced, and also where they could be most cheaply and effectively made into articles of commerce. When this information was obtained, competition must come to a practical end. It was for statisticians to take up these discoveries when made, and to teach commerce to look upon organisation, not competition, as its end, so that competition might ultimately point the way to a higher organisation, so that we should no longer have unrestricted competition in commerce any more than in our streets, where even two omnibuses were forbidden to race side by side.

Dr. Yeats, in reply, agreed with the first speaker that papers might be made shorter with advantage to the audience, but they were really intended for the careful and deliberate perusal of all members of the Society, numbering about 4,000, and, therefore, had to be complete in every detail as far as possible. They were intended to stimulate thought rather than to settle any one particular point. The school hours at Leipzig and Marseilles were about 36 per week, but he had not given the details, lest it should alarm English prejudices, for

instance with regard to the attendance on Sundays and at early hour in the morning for apprentices. No doubt he had missed the main point from Mr. Mast's view, but he had addressed himself especially and plainly to young men after their ordinary period of school life, and his object was to show them that if they meant to go into competition with the rest of the world—a competition which they could not avoid—they should, for their own sakes, place themselves on an equal footing with others. He had not instituted comparisons between English and foreign methods of teaching, or perhaps he might show that we were not so very far behind; but, on the other hand, he was anxious that all should learn wherever it was possible to get a good idea. It would have been an impertinence on his part to attempt to instruct English educators on their methods of teaching. Mr. Price had spoken of special training for different branches; but he had forborne going into what was termed industrial instruction, his topic being commercial education, which was not so much concerned with production as distribution. Still, for this distribution to be effected efficiently and profitably, a certain preparation appeared in other countries indispensable, and that preparation was not general in England, nor was it so perfect as was to be found abroad. He would cordially recommend young men to go abroad and attend foreign schools, and could assure them, from his own experience, going alone and without introduction, that they would meet with a cordial welcome. He could add nothing to what had been said as to the importance of moral culture. Everyone knew that commerce depended on credit, by which he did not mean the power to run long bills. Men bought and sold who knew nothing of each other; but good faith existed between them, and could only be maintained by the constant inculcation of the broad principles of morality. These existed (to his mind) nowhere to a greater extent than amongst mercantile men; they seem to have the faculty of appraising things at their true value; they were not bigoted in their opinions, but would take anything at its real worth if they could find it out, and if they could not, they would blame no one but themselves. The last question—as to how employers and workmen were to be put on a better footing—was a more difficult one, and would take too long to go into. He would venture to say, however, that Mr. Pullar and he did not widely disagree, and though the former had dealt only with the material aspect of the question, he would yet acknowledge that mind was somewhat superior in its action to any merely material circumstance. He contended that competition, when pushed to the extreme, would bring about some form of co-operation; useless competition would cease; people would agree that a certain amount of work had to be done, and would try and do it in the cheapest manner. He believed that the effect of higher education on the artisan class would be the same here as seen in America. The Americans affected to deride much of the work done by English artisans, and said they were not going to lower themselves to be mere machine-minders, that a man was the finest machine of all, and they bound themselves together in little knots, and addressed themselves to the production of automatic machinery until they went far to displace the skilled labour of Europe. To give an illustration, Americans now produced watches no part of which was made by hand. Every bit was made by an automatic machine, and then the watch was adjusted by machinery. Watches were thus produced which the world could not compete with, and Switzerland had entirely lost her American trade; in fact, the Swiss workmen, if they took one of these to pieces, could not put it together again. The cause of this improvement was the superior culture of the American workman; he could obtain a patent for his invention, and he worked with his brain instead of with his fingers. Nearly all the agricultural tools which came into the district where he lived came from America; and to show the independence of spirit cultivated there, he might mention a fact within his own knowledge, that an American contractor engaged in a large public work in his neighbourhood, a man of means and position, was not ashamed to black his own boots.

The Chairman, in proposing a vote of thanks to Dr. Yeats, said he should have liked to say a word or two on technical education had time permitted, but, as it was late, he would simply refer those interested in the subject to a little work published by Rivington's for 6d., giving an account of the weaving and technical schools on the Continent.

The motion having been carried,

Dr. Yeats, in reply, briefly alluded to the great efforts made by the Chairman in favour of technical instruction, especially in Scotland, and quoted as applicable to him, the poet's lines respecting one who lived:—

> "For the cause that needs assistance,
> For the wrong that needs resistance,
> For the future in the distance,
> And the good that he can do."

MISCELLANEOUS.

NATIONAL CULTIVATION OF MUSIC.

On the 30th January, a meeting of clergymen of the Church of England, convened by the Bishop of Manchester, was held on the premises of the Young Men's Christian Association, Peter-street, Manchester, to consider a statement by Sir Henry Cole respecting a scheme for improving and giving more vigour to the national cultivation of Music. The Bishop of Manchester presided, and about fifty clergymen were present.

A printed statement which had been previously circulated was as follows:—

1. Among all branches of the fine arts, Music exert and has always exerted, the highest influence on all peoples. Music is necessary in all religious and military services, and on all festive occasions. It affords innocent recreation in all homes. It soothes the babe soon after it is born, and it is part of the service for the burial of the dead. But universal as its uses are, the study of it needs improved organisation in this country, and wants something of the combined action which is found abroad. And there are numerous agencies at work in this country, which, if brought into a harmonious union, would produce better results than are at present forthcoming.

2. The Education Department is entrusted by Parliament to pay yearly one shilling on behalf of every child in public elementary schools, where it is reported that the children are able to sing, and this grant may in time amount to £100,000 a year. [It now exceeds £90,000!] It would be an outlay in the interests of civilisation well spent. But no proper arrangements have yet been made to teach singing, more than by ear, in public elementary schools, or for examination, or to select those young persons for further training, whom Heaven has endowed with musical genius. This work, chiefly by examinations, might easily be done by a competent agency in great towns, such as the Owens College in Manchester.

3. There are schools and classes of science and art in all large towns, but there are no public schools for Music, which is both a science and an art, where elementary Music might be taught, and it appears most desirable that public local music schools and classes should be established, especially to develop the musical ability dormant among three millions of children, and utilise that ability for general benefit.

4. There are numberless associations for the practice of Music; and whilst the people are tempted to visit music-halls connected with public houses, they are not attracted to churches and chapels when they are unused, as they might be, to join in services of song, by which they would be weaned from gross and debasing pursuits

5. There are several institutions in the metropolis be-

sides the Royal Academy for Music, where the well-to-do classes may study on payment of fees. There is the National Training School for Music, established at South Kensington, which numbers about ninety students, who are admitted free and solely by merit, which is ascertained by public competition throughout the country. This school might well be used to complete the musical education of the country, begun in public elementary schools and continued in local musical schools, if it acted in union with them.

6. It may be useful to state what the country has done for promoting a knowledge of science and art. After the close of the Great Exhibition of 1851, the Government resolved to establish schools of art and science, where the people might desire to have them, and the results have been great. Then there was no science teaching aided by the State. In 1876, there were 1,426 schools, with 57,988 students in 24 subjects of science; whilst in art the 17 schools in 1851, had increased in 1876, to 141 schools, with 27,973 students; 883 night-classes, with 31,158 students; and 3,335 public elementary schools, where elementary drawing is taught to 460,961 children.

7. It cannot be doubted that an analogous system might be organised throughout the country for Music, and it has been proposed, with the assistance of those who desire to elevate the masses of the people, to try and organise it, and to make a beginning in Lancashire. At the Owens College, Manchester, there are already musical classes for teaching harmony and choral singing, and this beginning might readily be used for examinations, and for further action if demanded by the public.

8. Support in promoting Music has been promised by several influential persons in the county of Lancashire, some being willing to help the National Training School for Music, some the establishment of local schools, and some the increased use of churches and chapels in respect of Music. In due time, probably, it might be desirable to hold one or more public meetings in important districts of the county. In the meantime Mr. Edward Hecht, the Professor of Music at Owens College, has consented to act as hon. secretary for the county of Lancashire, and will be happy to receive the names of well-wishers to the National Cultivation of Music.

Sir Henry Cole, K.C.B., said although for a quarter of a century he had been engaged in another branch of the fine arts, he had always held the conviction that the highest and most important among the Fine Arts was Music, and he hoped his hearers would agree with him that the cultivation of Music was quite as worthy of being properly assisted by the State as drawing and painting. If they looked at the history of the subject as given in the Bible, they would find that from the earliest periods of civilisation, Music had always held a high place, and performed an important part in the culture of the people. Singing was taught in the public schools at the present time. What did the inspectors say about the matter? Mr. Campbell, of Chelsea, said the singing in schools has very materially deteriorated within the last three years. It is very rarely now that hearty part-singing is heard in the best schools. He found from an educational Bluebook that the number of elementary schools more or less connected with the National Society or the Church of England was 10,046, and that the scholars under inspection in them was 1,790,000; while the remaining elementary schools in the country were only 4,227, with 4,148,000 children under inspection. Thus it appeared that the schools and scholars connected with the Church of England were much more than double all the other denominational schools and scholars in the country; and therefore a great power for furthering the cultivation of good Music rested with the Church of England. As they were aware, the Government had authority to spend £100,000 per year if they thought necessary on the teaching of Music in elementary schools, and there was some little show of instruction in the art, but the performance in most cases merely amounted to the singing in unison of songs which had been learned by ear. It was necessary therefore, to make some effort to establish musical instruction on scientific principles in connection with day schools. The clergy must especially remember that in proportion as the singing in schools was well taught and well practised the singing in church would be well executed. It was obvious that the first practical step towards the object in view, was to obtain good teachers; and he suggested that a number of schools might jointly engage a properly qualified teacher of singing, to whom they might give something like £150 a year, on condition that he paid one or more visit weekly to each of the schools joining the arrangement, and taught the scholars to sing. If there were anything like a thorough national organisation for the purpose proposed, not only would the Government in all probability make a larger grant of money for its support, but the public would no doubt assist also. Prizes might be given with good results to the children who excelled in the study of Music. In great centres like Manchester, Birmingham, Bristol, Sheffield, and London Training Schools for teachers in elementary schools might be established, and thus a supply of musical teachers would be assured. England was below every other country in Europe with regard to national cultivation of Music, although the English had fine voices for singing, and were able, if they chose, to establish a musical training system on the very grandest scale.

The **Bishop** said that if they could do anything in the direction suggested by Sir Henry Cole—anything that was rational and not inconsistent with the higher objects which they had in view—it might be well to try the experiment. Some of them might be a little frightened at the sound of trumpets and drums in the churches, but the feeling would only be of a transiont character.

The **Rev. Dr. Burton** moved:—"That the national cultivation of Music for the due performance of religious services, and for promoting the enobling recreation of the people, is deserving the encouragement of all, and especially of tho clergy of the Church of England; and that such encouragement might be afforded by improving Music in elementary schools."

The **Rev. J. A. Atkinson** seconded the motion, which was carried unanimously.

The **Rev. T. A. Stowell** moved, and the **Rev E. P. Anderson** seconded, the following resolution, which was also adopted:—"That this meeting considers that it is desirable, for the purpose of securing efficient instruction in Music in elementary schools, that a system of certified inspection, similar to that adopted with reference to science and art, should be instituted."

The **Rev. J. N. Pocklington** proposed that, pending any action in the matter on the part of Government, a local committee, consisting of the Dean of Manchester, the Rev. Dr. Burton, Rev. J. A. Atkinson, Rev. T. A. Stowell, Rev. E. P. Anderson, Rev. J. N. Pocklington, and Rev. Canon Elvy (hon. secretary), with power t add to their number, should be formed for the purpos of considering what steps ought to be taken to promo the better teaching of Music in elementary schools.

The **Rev. A. B. Clarke** seconded the motion, which was agreed to unanimously.

A discussion followed on the desirability of holding musical services in churches on the evenings of work days; and ultimately the Rev. G. W. Reynolds (St. Mark's, Cheetham), Rev. Dr. Burton (All Saint's, Oxford-street), Rev. T. Wheeler (St. Stephen's, Salford), and Rev. A. E. Welby (Holy Trinity Church, Stretford-road), agreed to combine, for the purpose of testing the question by an experiment.

Votes of thanks to Sir Henry Cole for his address, and the Bishop for presiding, terminated the proceedings.

ADULT INSTRUCTION THROUGH PUBLIC MUSEUMS.

(Subsidised by Parliament.)

The following results, giving important information bearing on public education, are obtained as correctly as possible, from inquiry and Parliamentary returns, in the hope that they may hereafter be officially collected and published periodically, like the Registrar-General's returns. The number of visitors for the month of January, 1878, are stated. When they are counted by sight the letter "S" is used, when by turnstile the "M":—

Institutions.	Amounts voted in 1877.	Number of Visitors in January.	How counted.	Observations.
1. British Museum	£ 109,990	28,086	S	Return refused. Open Mondays, Wednesdays, Fridays, and Saturdays. Closed, except to students, on Tuesdays and Thursdays. (1)
2. National Gallery, Charing-cross	6,976	..	S	Open Mondays, Tuesdays, Wednesdays, and Saturdays. Closed on Thursdays and Fridays. Open from 10 to 6. (2)
3. Kew Gardens and Museum	22,622	10,134	S	Open on Sundays and week days. (3)
4. South Kensington Museum	38,922	79,118	M	Open morning and evening till 10, on Mondays, Tuesdays, & Saturdays. Students' days—Wednesday, Thursday, & Friday, 6d. entrance. Open from 10 till Sunset.
5. Bethnal-green Museum	7,600	41,416	M	Ditto. (5)
6. National Portrait Gallery, South Kensington	2,000	..	M	Return refused. Open daily except Sundays. (6)
7. School of Mines and Mining Record Office, Geological Museum, Jermyn-street	8,997	4,900	M	Open daily, except Sundays and Fridays, and in the evenings till 10 of Monday, Tuesday, and Saturday. (7)
8. Patent Office Museum, South Kensington	..	19,554	M	Open daily, except Sundays. (8)
9. Edinburgh National Gallery	2,100	20,515	M	(9)
10. Edinburgh Museum of Antiquities	..	18,070	M	(10)
11. Edinburgh Museum of Science and Art	10,998	43,593	M	Open daily (10 a.m. to 4 p.m.) except Sundays, and Friday and Saturday evenings (6 to 9). Students' days—Monday, Tuesday, & Thursday; admission 6d.; other days, admission free. (11)
12. Edinburgh Botanic Gardens	1,750	2,158	M	(12)
13. Dublin Museum of Natural History	1,762	9,462	M	Open daily, & in the evening. (13)
14. Glasnevin Botanical Gardens and Museum	2,224	4,259	M	Open daily, including Sundays. (14)
15. National Gallery of Ireland	2,389	..	M	(15)
16. Museum of Royal Irish Academy, Dublin	300	..	M	(16)
17. Zoological Gardens, Dublin	500	3,341	M	Open daily, including Sundays. Number of visitors in July, 15,281. (17)
18. Tower of London	1,590	22,922	S	Open daily, except Sundays. (18)
19. Royal Naval College, including Greenwich Painted Hall	38,051	21,148	S	Open daily, including Sundays. (19)
20. Royal Naval Museum, Greenwich	1,055	3,835	S	Open daily, except Fridays and Saturdays. (20)
21. India Museum, South Kensington	..	1,534	M	Paid for by Indian Government. Open on Mondays, Tuesdays, Fridays, and Saturdays, 1d. admission; on Wednesday and Thursday, 6d. admission. (21)
22. Hampton Court Palace	7,475	2,710	..	Open on Sundays, and on week days except Fridays. (22)

(1) The numbers are those for the corresponding month of the previous year, as given in the Parliamentary Return.
(7) Number of visitors in the morning, 2,200; evening, 2,700—total, 4,900.
(11) Total number for 1877, 372,585.
(13) Visitors in the daytime, 2,317; evening, 7,145—total, 9,462.
(14) Visitors on Sundays, 2,480; week-days, 1,779—total, 4,259.
(12) (15) (16) No information as to opening.

CORRESPONDENCE.

THE ART MANUFACTURES OF JAPAN.

At the close of the unreasonably long paper which I read at the Society of Arts on Wednesday last, Mr. Beck asked me how how the large Japanese vases that we are accustomed to see can be made on the potters' wheels such as I described; time did not permit, or I would have answered his question at the time, but if you can kindly give me space I will now answer it. All large objects are, so far as I saw, made in pieces. If the vase is to be three feet high, it is made in six or eight hoop-like parts, and after each piece has been separately made, the parts are fastened one upon another as a second operation.

The potter's wheel is a well-poised, heavy stone, and is not small; indeed, it retains its momentum, when once set in motion, for a considerable time, owing to its weight.

Having answered Mr. Beck's question, I may say that a gentleman—who appeared to be well informed upon the subject of which he spoke—came to me at the close of the meeting, and said that a Cunard steamship now building in Glasgow was having its saloon fitted with panels of Japanese lacquer, but that no other Japanese wsrk was being employed, either in its structure or for its embellishment. A. W. Dresser.

Tower Cressy, Notting-hill, W., Feb. 2nd.

GENERAL NOTES.

American Patent-office.—The American Commissioner of Patents states that he estimates that about one-third of the 90,000 patented models that were in the late fire were of metal, and that probably one-third of these metal models were so little damaged that, by cleaning, polishing, &c., they could still be made available for exhibition and for a fuller understanding of the invention when the drawings and specifications fail, as they often do, to throw sufficient light on the inventions they are supposed to describe. The amount requisite to clean, identify, and re-arrange these damaged models, including the cases to contain them, the Commissioner estimates at 8,000 dols. In the fire, many thousand complicated models in the classes of sewing, spinning, and weaving, were drenched by water, and are rapidly corroding. Many of these will require taking to pieces, cleaning, and polishing, which the Commissioner thinks will cost about 1,000 dols. more, and therefore asks for an appropriation of 9,000 dols. for this purpose.

Cultivation of the Cinchona in the United States.—It would appear from the report of the Commissioner of Agriculture, says the *Pharmaceutical Journal*, that an attempt which has been made to introduce the cultivation of the cinchona into the United States has not up to the present time turned ont very favourably. During the past ten years a continuous supply of young plants of several species of cinchona has been maintained by a yearly propagation of young plants equal to the numbers distributed. Plants have been sent to California and to several of the Southern States, mainly to Florida. The reports that have reached the department do not indicate success in their cnlture, owing to adverse climatic influences. Experiments here show that none of the species will stand the slightest frost without injury, and even in the equable atmosphere of the greenhouse their vitality is impaired when the temperature is below 50°. Whether or not the climatic conditions for the growth of cinchonas exist in any portion of the United States is a question not yet solved, but, so far as present knowledge warrants an opinion, further experiments should be confined to the locality of San Diego, California, as offering greater promise of success than any other point.

Glass Veneers.—The *Journal of Applied Science* says that the manufacture has recently been granted in New York of what is termed "glass veneers and decorations on glass" consisting of plate glass painted on the back, which is glued to the wood or other material it covers or adorns. Specimens of their work are excellent imitations of the various woods represented—such as birch, ash, French walnut, grey maple, rosewood, mahogany, bird's-eye maple, satin wood, &c. For panellings, wall and ceiling decorations, marquetry, imitations of the different marbles, tiles, &c, we know of nothing to equal this new manufacture, and predict for it a great success, combining as it does cheapness and beauty. Mr. Budd, the inventor, has had a pianoforte in use for the past two years, covered with glass veneer, during which period it has been removed three times without breakage, or even a scratch.

Electric Engraving on Glass.—A short time ago, M. Gaston Planté, in causing a powerful electric current to enter a voltameter by means of a platinum electrode in a glass tube, observed that the glass was deeply corroded by the discharge. Following up this discovery, M. Planté has now communicated to the French Academy of Sciences a process of engraving on glass and crystal by means of electricity. The process consists in covering the plate to be engraved with a concentrated solution of nitrate of potash, put in connection with one of the poles of the battery, and in tracing out the design with a fine platinum point connected to the other pole. The results are said to be of marvellons delicacy. The battery employed by M. Planté was composed of fifty or sixty secondary elements. Round articles can be engraved by adding gum to the solution to make it adhere.

NOTICES.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at eight o'clock. The following arrangements have been made:—

February 13.—"The Systems of Cremation in Use upon the Continent." By W. Eassie, Esq. Higford Burr, Esq., will preside.

February 20.—"The Steam Tramways of Paris," by J. L. Haddan, Esq., M.I.C.E. Col. Beaumont, R.E., will preside.

February 27.—"The Past, the Present, and the Future of the River Thames." By J. B. Redman, Esq.

March 6.—"An Electric Lamp-lighting System." By St. George Lane Fox, Esq.

March 13.—"The Type-writer." By R. Brudenell Carter, Esq., Member of the Council of the Society.

March 20.—"Emery and Corundum Wheels for Grinding and Surfacing Metals and other Materials." By A. H. Bateman, Esq., F.C.S.

March 27.—"Musical Education at Home and Abroad." By Alan S. Cole, Esq.

April 3.—"Our Wealth in Relation to the Imports and Exports of the Country," by E. Seyd, Esq. W. Hawes, Esq., F.G.S., will preside.

African Section.

Tuesday evenings, at eight o'clock. The following arrangements have been made:—

February 19.—"Egyptian Obelisks and their Relation to Chronology and Art." By Basil H. Cooper,

Esq., B.A. Admiral Sir Erasmus Ommanney, C.B., F.R.S., will preside.

Indian Section.

Friday evenings at eight o'clock. The following arrangements have been made :—

February 22.—"Irrigation Regarded as a Preventive of Indian Famine." By W. T. Thornton, Esq., C.B.

March 15.—"The Colonisation of Hill Districts in India." By Lieut.-General McMurdo, C.B. Edwin Chadwick, Esq., C.B., will preside.

March 29.—"The Depreciation of the Value of Silver, with Especial Reference to the Exchange between India and England, and Suggestions for a Remedy." By Col. J. Smith, R.E., late Superintendent of Madras Mint.

Chemical Section.

Thursday evening at eight o'clock, The following arrangements have been made :—

February 14.—"Recent Improvements in the Metallurgy of Nickel." By A. H. Allen Esq., F.C.S.

February 28.—"The Chemistry of Infection, or the Germ Theory of Disease from a Chemical point of View." By C. T. Kingzett, Esq., F.C.S.

Additional Lectures.

A Course of Three Lectures, on "Explosions in Coal Mines," is now in course of delivery, by T. Wills, Esq., F.C.S. The remaining lecture will be delivered on Monday, February 11th, at Eight o'clock.

Lecture III.—February 11th.

Connection of the variations of atmospheric pressure with explosions in coal mines. Dangers attending blasting operations in coal mines. Action of coal-dust in certain classes of explosions. The use of the safety lamp as an indicator of the presence of fire-damp, also as a means for its quantitative estimation.

Cantor Lectures.

Monday Evenings, at Eight o'clock. Second Course, on "The Application of Photography to the Production of Printing Surfaces and Pictures in Pigment." By Thomas Bolas, Esq., F.C.S.

Lecture I.—February 18th.

Photo-lithography and photo-zincography.

Lecture II.—February 25th.

Phototypic, or raised printing blocks, by swelled gelatine process, zinc etching, and other methods.

Lecture III.—March 4th.

Line engraving on metal plates.

Lecture IV.—March 11th.

Printing of half-tone subjects from metal. Application of Asser's process. Talbot's Photo-engraving. Woodbury's methods for engraving and printing.

Lecture V.—March 18th.

Collotypic printing.

Lecture VI.—March 25th.

Other methods of producing photographs in pigment. Dusting-on method. Autotype printing.

Third Course, on "Some Researches on Putrefactive Changes, and their Results in relation to the Preservation of Animal Substances." By B.W. Richardson, Esq., M.D., F.R.S. April 8, 15; May 6, 13, 20, 27.

MEETINGS FOR THE ENSUING WEEK.

Mon.....**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Additional Lectures.) Mr. Thomas Wills, "Explosions in Coal Mines." (Lecture III.)
Royal United Service Institution, Whitehall-yard, S.W., 8½ p.m. Lieut.-Col. J. H. A. Macdonald, "The Best Detail Formations for Infantry Attack."
Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Discussion upon Mr. J. Smalman Smith's Paper, "The Law of Support in its Relation to Land, Mines, and Buildings."
Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m.
Medical, 11, Chandos-street, W., 8.30 p.m.
London Institution, Finsbury-circus, E.C., 7 p.m. Lieut. Francis I. Palmer, "The History of the Torpedo."
Social Science Association, 1, Adam-street, Adelphi, W.C. 8 p.m. Captain Douglas Galton, "The Report of the Royal Commission on Railway Accidents."

Tues....Royal Institution, Albemarle-street, W., 3 p.m. Prof. Garrod, "The Protoplasmic Theory of Life and its Bearing on Physiology." (Lecture IV.)
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. J. G. Longridge, "Evaporative Power of Locomotive Boilers."
Photographic, 5a, Pall-mall East, S.W., 8 p.m. **Annual Meeting.**
Anthropological Institute, 4, St. Martin's-place, W.C., 8 p.m. 1. Mr. H. C. Sorby, "The Colouring Matter found in the Human Hair." 2. Mr. C. C. Jones, "Bird-Shaped Mounds in Putnam County, Georgia, U.S.A."

Wed....**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr. W. Eassie, "The Systems of Cremation in Use upon the Continent."
Graphic, University College, W.C., 8 p.m.
Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m.

Thur....**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Chemical Section.) Mr. A. H. Allen, "Recent Improvements in the Metallurgy of Nickel."
Royal, Burlington House, W., 8½ p.m.
Antiquaries, Burlington House, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 7 p.m. An Illustrated Musical Lecture by Mr. Ernst Pauer.
Royal Institution, Albermarle-street, W., 3 p.m. Prof. Dewar, "The Chemistry of the Organic World." (Lecture IV.)
Royal Historical, 11, Chandos-street, W., 8 p.m. 1. Dr. Gustavus Zerffi, "The Historical Development of Idealism and Realism." (Part III.) "The Scholastic Period." 2. Mr. Sidney Robjohns, ' Canada Past, a Key to Canada Future."
Royal Society Club, Willis's Rooms, St. James's, S.W., 6 p.m.
Mathematical, 22, Albemarle-street, W., 8 p.m. 1. Prof. Lloyd Tanner, "A General Method of Solving Partial Differential Equations." 2. Mr. H. B. Kempe, "A Property of a Four-piece Linkage, and a curious locus in Linkages."

Fri.......Royal United Service Institution, Whitehall-yard, 3 p.m. Admiral the Right Hon. Lord Dunsant, "The Laws and Customs of War, as Limiting the Use of Fire-ships, Explosion-vessels, Torpedoes, and Submarine Mines."
Royal Institution, Albemarle-street, W., 8 p.m., Weekly Meeting. 9 p.m., Dr. P. L. Sclater, "Zoological Distribution and some of its Difficulties."
Geological, Burlington House, W., 1 p.m., Annual Meeting.
Philological, University College, W.C., 8 p.m. 1. Mr. A. J. Ellis, "Engytype, or Approximate Phonetic Writing for Philological Purposes." 2. (Probably) M. Gunlögsen, "Philosophy of Language," or "Icelandic."

Sat.......Working Men's Club and Institute Union (at the House of the Society of Arts), 4 p.m. Mr. S. Brandram's Readings. Part I. Selections from "Merchant of Venice." Part II. Miscellaneous
Physical Science Schools, South Kensington, S.W., 3 p.m. Mr. H. F. Morley, "Grove's Gas Battery." Mr. S. C. Tisley and Mr. Stroh, "The Drawing of Lissajou's Figures for the Stereoscope by his Pendulum Apparatus."
Royal Institution, Albermarle-street, W., 3 p.m. Mr. Bosworth Smith, "Carthage and the Carthaginians." (Lecture IV.)

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,317. VOL. XXVI.

FRIDAY, FEBRUARY 15, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

WATER SUPPLY OF TOWNS.

The following letter has been received from H.R.H. the President of the Society:—

Clarence-house, St. James's, S.W.,
30th January, 1878.

SIR,—The supply of pure water to the population is at the present time exciting deep interest throughout the country. Our great cities and populous towns, such as Manchester, Liverpool, Birmingham, and others, are, each for itself, taking steps to obtain an improved and increased supply, whilst the metropolis is seeking further powers from the Legislature with the same object in view. The smaller towns and villages are dependent on accidental sources of supply, and in many instances these are wholly inadequate for health and comfort. While the larger populations are striving, each independently and at enormous cost, to secure for themselves this article of prime necessity, the smaller localities must make the best shift they can, and in many instances are all but without supply at all.

Under these circumstances, I would draw the attention of the Council to the subject, and suggest whether, at the present time, great public good would not arise from an open discussion of the question in the Society's rooms, with a view to the consideration of how far the great natural resources of the kingdom might, by some large and comprehensive scheme of a national character, adapted to the varying specialities and wants of districts, be turned to account, for the benefit, not merely of a few large centres of population, but for the advantage of the general body of the nation at large.—I have the honour to be, Sir, yours faithfully,

(Signed) ALBERT EDWARD P.,
President of the Society of Arts.

To the Chairman of the Council of the Society of Arts.

This communication was laid before the Council at their last meeting, and it was resolved that a Committee be formed to consider the best means of carrying into effect the proposition of the Prince of Wales, and that the Secretary be desired to inform his Royal Highness that the Council would take immediate steps to secure the discussion of the subject as suggested.

The following is the reply sent in accordance with these instructions:—

Society of Arts, John-street, Adelphi, W.C.
13th February, 1878.

SIR,—I am directed by the Council of this Society to acknowledge the receipt of your Royal Highness's letter of the 30th of January, addressed to the Chairman, and to express to your Royal Highness their high estimation of the importance of the subject which your Royal Highness has brought to their consideration. It will afford the Council much gratification to carry out your Royal Highness's most valuable suggestion, and they will at once take steps for securing a public discussion on this subject.—I have the honour to be, sir, your Royal Highness's most obedient servant,

(Signed) P. LE NEVE FOSTER, Secretary.

LIFE MEMBERS.

In accordance with the bye-law No. 66, quoted below, the Council have elected the following life members:—

PROF. ALEXANDER GRAHAM BELL, in consideration of his invention of the Telephone.

MR. HENRY M. STANLEY, in consideration of the services to Commerce by his explorations in Africa.

Bye-law No. 66.—The Council shall have power in each year to admit five persons, eminent in Arts, Manufactures, or Commerce, or in the applications of abstract science to the same, as life members of the Society, without the ordinary formalities of election, and without payment of any subscription whatever.

UNIVERSAL CATALOGUE OF PRINTED BOOKS.

His Royal Highness the Prince of Wales, K.G., President of the Society of Arts, has referred to the Council the subject of the cost of producing a universal catalogue of all books printed in the United Kingdom up to the year 1600.

This idea originated with Mr. Dilke (grandfather of the present baronet), who published it in the *Athenæum* of the 11th May, 1850. It was brought to the notice of the Society of Arts as far back as December, 1852, and two years ago, just before the Prince of Wales started for India, a printed specimen of such a catalogue was submitted to his Royal Highness.

The Council of the Society, being desirous of collecting information to enable them to report to their President, will feel greatly obliged if librarians, publishers, and printers, will kindly give replies to the following questions, and return them, answered, to the Secretary on or before 15th February, 1878.

QUESTIONS.

1. As it is proposed to issue the catalogue in sections, do you approve of dividing the catalogue into periods, say, of fifty years? If not, please say what other periods you recommend.

2. Do you approve of the size of the proposed page and type?* If not, what do you suggest?

3. Would you be willing to attend a meeting of the Council, and give explanations of your views generally on the subject?

Explanation of The Proposed Catalogue.

1. Since the year 1851, when the Exhibition of the Works of Industry of all Nations took place in London, the idea, first promulgated in the *Athenæum* of 11th May, 1850,† p. 501, that a universal catalogue of the titles of all books which have been printed since the invention of printing would be of great value to literature and to all public libraries, has been discussed.

2. To some this idea has seemed to involve a large and difficult work to carry out, and the proposal has lain dormant for more than a quarter of a century. It appears that the work can be done, and that it is only necessary that the public libraries of countries which have a printed literature should enter into a convention to do the work, and do it by degrees, extending to books printed before the year say A.D. 1800, or even a little later.

3. That this conclusion may not be called a vague one, a specimen has been prepared to show practically how the work might be carried out, and what it would produce when carried out. There has been correspondence with eminent men, possessing fine libraries, or learned in literature and Bibliography. Amongst these, the names of the Duc d' Aumale, Lord Acton, Sir James Lacaita, Sir John Lefevre, and Mr. Winter Jones, the principal librarian of the British Museum, may be cited as having thought sufficiently well of the project to encourage proceeding.

4. It is proposed that the titles of books, to form the basis, shall be arranged chronologically—at the beginning of printing into long periods, and afterwards into decades, or even years, as found convenient. As a beginning, it is proposed that the first division of the catalogue shall be produced as far as the year A.D. 1550.‡

5. It is proposed that all the titles up to A.D. 1550 shall be arranged alphabetically, according to the names of the authors, or, in the absence of these, according to the subjects.

6. Division A§ of this specimen takes a few titles in several languages, and shows how it is proposed that the basis of the catalogue shall be formed and set up by each country. Other divisions show how Division A may be cut up, and the titles of the books interwoven, the catalogues of all countries being thus arranged together alphabetically, chronologically, according to subject-matter, or in such other ways as the exigencies of any particular library may require.

7. It is proposed that each nation shall compile and publish the titles of all the printed books which have been produced in it, according to Division A (adopting details to be agreed upon). Whatever may be the language of the books, the titles would be given as printed. Each country would publish a given quantity of the titles at fixed periods, which should be printed in the same style, measure, and sized page as this specimen, and, like it, on one side of the leaf only. It might be convenient if each country used a different coloured paper, thus:—United Kingdom, red; France, green; Italy, brown; Germany, blue; Spain, orange; Flanders, neutral tint, &c.; or printed in a special coloured ink.

8. Every library might thus obtain a printed catalogue, reasonably complete for given periods, made once and for all, till the end of the world. Such a catalogue might also show what books the library possessed, and what books were wanting. Such a work has never been prepared as now suggested, and the want of it renders the compilation of perfect catalogues of books impossible. Such a collection of titles once made, would serve as the basis of every kind of classed catalogues.

9. A convention between the Princes of Europe* was formed by his Royal Highness the Prince of Wales, at the Paris Exhibition of 1867, with the view of all countries assisting one another in obtaining reproductions of works of art. This convention would be most useful now. The Secretary of State might be asked to send these specimens, through the Foreign Office, to every country which has a literature printed before A.D. 1550, with an invitation to the Government of each to co-operate in the proposed work, to make arrangements for printing, as suggested, titles of the books which belong to it, and nominate an authority to correspond upon the subject.

Specimens of the Catalogue.

ENGLISH.

Specimen of Division A.

The Alphabetical arrangement of the Titles up to A.D. 1550 *to be furnished by each Country.*

[*United Kingdom*]

Andrea Antonius ......1480 ....Metaphysics
End. Excellentissimi sacre theologie pfessoris Anthonii Andree ordinis fratrū minorū super duodecim libros Methaphisice questionibus per venerabilem virū magistrū Thomā penketh ordinis [sic] fratū Augustinensiū emendatis finis impositus est per me Johannem letton ad impensas Wilhelmi Wilcock impressis. Anno Xpi M.CCCC.LXXX. *Brit. Mus.*

[*United Kingdom*]

Heraclius..............1481.............. Fiction
[fol. 10.] Here begynneth the boke entituled Eracles, and also of Godefroy of Boloyne. *End.* Which boook [sic] I began in marche the VII. daye and fynysshed the VII. day of Juyn, the yere of our lorde M.CCCC.LXXXI. and the XXI. yere of the regne of our sayde Sauverayn lord kyng Edward the fourth. And in this maner sette in forme and enprynted the XX. day of novembre the yere aforesayd, in thabbay of Westmester by the sayd Wylliam Caxton. *Brit. Mus.*

[*United Kingdom*]

Christyne (of Pyse).... 1478 .... Proverbs
The Morale Prouerbes of Christyne (of Pyse) Enprinted by Caxton. In feuerer the colde season. Folio. (A.D. 1478.) *Bib. Miller. Britwell.*

[*United Kingdom*]

Caxton, William ......1474................ Games
The Booke of the Game and Playe of the Chesse [Translated out of French, and printed by William Caxton.]

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* A specimen of the proposed catalogue may be seen at the Society of Arts, Adelphi, between the hours of 10 and 4, or a copy will be sent for inspection, to be returned.

† The article on this subject was written, it is believed, by Mr. Dilke, the grandfather of the present Baronet.

‡ Two works have partially carried out, in different ways, a catalogue of books printed before 1500:—Panzer, G. W.—Annales Typographici ab artis inventæ origine ad annum MD., post Maittairi, Denisii aliorumque doctissimorum virorum curas in ordinum redacti, emendati, et aucti. Opera G. W. P.; 11 vols. 4to.; Norimbergæ; 1793-1803. Hain, L.—Repertorium Bibliographicum, in quo libri omnes ab arte typographica inventa usque ad annum MD.; 4 vols. 8vo.; Stuttgart; 1827-38. These works, as well as others printed in England, will materially assist to carry out the idea in the form suggested.

§ It has been suggested by Sir James Lacaita that all notes of the cataloguist shall be given in Latin. He also proposes that the title shall state the size, the number of leaves which the book contains, also the number of blank leaves, any woodcuts, and if the book has an introduction and an index. Before finally settling these details, it may be desirable to have a conference—perhaps an international one—to discuss them. Sir James' views are illustrated by the page of "Italia." In the English division his views, in some respects, have also been carried out. The other divisions merely give titles for the present.

* This convention was signed by Albert Edward, Prince of Wales; Alfred, Duke of Edinburgh; Frederick William, Crown Prince of Prussia; Louis, Prince of Hesse; Albert, Prince Royal of Saxony; Prince Napoleon (Jerome); Philippe, Comte de Flandre; Alexandre Césarevitch de Russie, Nicolas Duc de Leuchtenberg; Oscar, Prince of Sweden and Norway; Humbert, Prince Royal of Italy; Amedee di Saivoie, Carl Ludwig, Archduke of Austria; Frederick, Crown Prince of Denmark.

Fynysshid, the last day of Marche, the yer of our Lord a thousand foure hondred LXXIIIJ. Folio.

[*United Kingdom*]

CAXTON, WILLIAM ......1480................POETRY
Ouyde his booke of Metamorphose Translated and fynysshed by me William Caxton at Westmestre the XXII. day of Apryll, the yere of our Lord M.IIIJC.IIIJXX. And the XX. yere of the Regne of kyng Edward the fourth.

[A manuscript copy of the latter part of the above is in the library of Magdalen College, Cambridge; a perfect copy is unknown, nor is it known whether or not it was printed.]

SPECIMEN OF DIVISION A.

[This portion was prepared by Sir J. Lacaita.]

The Alphabetical arrangement of the Titles up to A.D. 1550 *to be furnished by each Country.*

[*Italia*]

ALIGHIERI, DANTE ......1481.............. POETICA
Comento di Christophoro Landino Fiorentino sopra la Comedia di Danthe Alighieri poeta Fiorentino. (In calce.) Fino del Comento di Christophoro Landino Fiorentino sopra la Comedia di Danthe poeta excellentissimo et *impresso in Firenze per Nicholo di Lorenzo della Magna a di* XXX. *Dagasto.* M.CCCC.LXXXI.

In fol. magno, char romanis, cum 2 fig. (Baldini et Botticelli?) *Proemio, Vita di Dante* et alia, 12 ff. Text 372 ff. *Edito Princeps*, commentar-Landini. *Bibl. Chatsworth.*

[*Italia*]

AUGUSTINUS, Sanctus, AURELIUS....1477....THEOLOGIA
De Civitate Dei. (*In fine.*) Aurelii Augustini de Civitate Dei liber XXII. et ultimus explicit. *Impressumque est opus hoc Neapoli a diligenti magistro Mathia Moravo. Anno Christi* M.CCCC.LXXVII.

In 4to. char. goth. Capit. Rubricae 16 ff. Text 291 ff. *Bibl. Lacaita.*

[*Italia*]

EUCLIDES ....1482............MATEMATICA
Elementorum libri. (In calce.) Opus elementorū euclidis megarensis in geometriā arte. In id quoque Campani pspicacissimi comentationes finiūt. *Erhardus Ratdolt Augustensis impressor solertissimus Venetiis impressit. Anno salutis* M.CCCC.LXXXII. *Octavis Kalen* Jun.

In fol. cum figuris. Impress. praef. Joanni Mocenieo i. f. ff Text 135 ff. *Bibl. Lac*

[*Italia*]

LUCANUS, MARCUS ANNÆUS ......1477........POETICA
Pharsalia. (In calce.) *Opus impressu et diligenter emendatu sublimi Ingenio magistri Antonii Zaroti* (*Mediolani*) *ano domini* M.CCCC.LXXVII. die XXV. *mensis Madiy.*

In fol. parvo, char. rom. In calce-Pomponii Infortunati M. Annæi Lucani Vita 112 ff. *Bibl. Lac.*

[*Italia*]

PETRARCA, FRANCESCO....1488.............. POETICA
Triumphi del Petrarcha. (In calce.) Finisse il commento delli triumphi del Petrarcha composto per il prestantissimo philosopho Misser Bernardo da Monte illicinio da Siena. *Impresso in Venitia con grade diligentia per Bernardino da Novara nelli anni del nostro Signore* M.CCCC.LXXXVIII. *a di* XVIII. Aprile.

In fol. cum 6 fig. Prologus 3 ff. Text 146 ff. *Bib. Lac.*

NOTE.—The proposed catalogue is intended for special use in libraries.

ADDITIONAL LECTURES.

The third and concluding lecture of the course on "Explosions in Coal Mines," was delivered by Mr. T. Wills, F.C.S., on Monday evening last, at eight o'clock. The lectures will be published in the *Journal* later on, probably during the Easter vacation.

TECHNOLOGICAL EXAMINATIONS.

The Council have determined to add Telegraphy to the list of subjects in the Society's Technological Examinations.

The first examination will be held in May next. The syllabus for the use of Candidates has been prepared as follows:—

TELEGRAPHY.

Examiner—William Henry Preece, Esq., C.E.

Part I.—General Science.

1. **The Elementary Certificate.**—For this Certificate the candidate will be required to have passed in the elementary stage of

Subject 4. Pure Mathematics.
,, 9. Electricity and Magnetism.

2. **The Advanced Certificate.**—For this Certificate the candidate will be required to have passed in the advanced stage of the above, and in the elementary stage of

Subject 10. Inorganic Chemistry.
,, 8. Acoustics, Light, and Heat.

3. **Honours.**—For Honours, the candidate must have passed in the advanced stage in the above subjects, and in either of the following subjects:—

Subject 6. Theoretical Mechanics.
,, 7. Applied Mechanics.

Part II.—Technology.

1. The construction, character, and difference of the various batteries employed in telegraphy.
2. The measurement of electrical quantities, and the character of different instruments of precision used in measuring and testing.
3. The character and quality of the different timbers and poles used in the construction of lines of telegraph.
4. Their decay and modes of preservation.
5. The manufacture, difference, and character of iron and copper wire.
6. The manufacture, character, and value of the different insulating materials used in protecting wire for submarine and subterranean purposes.
7. The principles, construction, and action of the different forms of apparatus in use in England in conducting the art of telegraphy.
8. The various natural disturbances that occur during different seasons of the year in impeding or destroying telegraphic communication, and the methods of protection adopted.
9. The causes that retard the rate of working on long land or submarine lines.
10. The various systems in use to increase the capacity of wires for the conveyance of messages.
11. The construction of aerial lines of telegraphs.
12. The principles and practice of jointing.
13. The construction of submarine cables; their laying and repair.
14. The various modes of joining up circuits.
15. The mechanical testing of the various materials used in telegraphy.
16. Faults; their nature, prevention, and localisation.
17. The applications of electricity to railway working.

TENTH ORDINARY MEETING.

Wednesday, February 13th, 1878; HIGFORD BURR, Esq., in the chair.

The following candidates were proposed for election as members of the Society:—

Browne, Rev. M. C., Kineton, Warwick.
De Opéda, Señor Don Luis, 20, Rue Tilsit, Champs Elysées, Paris.
Grafton, Frederick William, 91, Portland-street, Manchester.
Richard, Charles Adolphe, 24, Cannon-street, E.C.
Riddell, Henry B., 50, Queen's-gate, S.W.

The following candidates were balloted for and duly elected members of the Society:—

Brooke, Captain W. Saurin, Bilaspur, Central Provinces India.
Grantoff, Albert, 17, St. Swithin's-lane, E.C.
Lenglet, Amand, 38, Finsbury-circus, E.C.
Skinner, Thomas, Naunton-villa, Carleton-road, Tufnell-park, N.

The paper read was—

THE SYSTEMS OF CREMATION NOW IN USE UPON THE CONTINENT.

By W. Eassie, C.E., F.L.S., &c.

The practice of cremation may now be said to have obtained a firm hold in various cities upon the Continent, and as the rite has been revived upon purely sanitary grounds, I have considered that a brief description of the means employed would possibly be interesting to our members. In 1877 sixteen cremations took place in the Milan district alone, with the full sanction of the Government, and they were attended by the municipal and sanitary authorities. It has also been legalised in Switzerland, and other countries—where, unlike England, the sanction of the Government has first to be obtained—are only waiting for the merest formalities previous to introducing it. In this latter category come France, Holland, Austria, Russia, and parts of Germany. In other portions of the German empire laws have already passed rendering it permissive, and I exhibit to you photographs of the plans and elevations of the beautiful crematory building now in course of erection at Gotha. The town and communal authorities there are interesting themselves greatly in this matter, and have taken especial care to see that the design for the mortuary, mortuary chapel, crematorium, and columbarium shall be worthy of imitation. The whole will be in working order during the summer of the present year.

The movement in favour of cremation in modern times originated with Professor Brunetti, and we all know that, when an account of the scientific benefits of the rite was diffused throughout the world in the English tongue, by the labours of Sir Henry Thompson, numberless responses arose from all parts. We have been only a little too sanguine in expecting its early adoption in our midst, and it is likely that much opposition will yet have to be overcome before it is largely practised. I do not now seek to make any comparisons between burial and cremation, but only to show what has been done and is about to be done in other countries in the direction of the latter. I will only say that since the abandonment of cremation for burial in the earth, a love for the former has never died out. Treatises upon the desirability of returning to it were common in every country soon after the invention of printing, and a halo of poetry always surrounded the idea.* From purely sanitary grounds I uphold it myself, not that I doubt the depurating power of the earth, to a certain extent, but rather that I, with others, do not see why the earth should be so fearfully encumbered with putrid and poisonous matter. Similar conclusions have been come to by all residents in vast cities. I may mention what will surprise many, and that is, that about the year 1844, the sanction of the authorities of the City of London was obtained for the cremation, within the City of London gas works, of the dead of Bridewell Hospital. An arrangement was also concluded with the City authorities for the cremation of the bodies of dead prisoners, and for the condemned meat and offal of the markets. The project, however, met with much opposition from various clerics, and the permission lapsed by non-usal.

Dr. Brunetti, who is Professor of Pathological Anatomy in the University of Padua, may with every reason, as I hinted just now, be styled the father of modern cremation. He was the first to devise an improvement upon the old-fashioned funeral pyre, such as was used in ancient Greece and Rome, and upon which were consumed, in modern times, the remains of the poet Shelley and of Williams. These cremations have been described in detail, notably by Trelawney in his "Last Days of Shelley and Byron," and the system followed in these cases would never recommend itself to persons who live in the full noontide of science, as we do at the present day. Even the cremation of the body of the Rajah of Kolapore, which took place in Florence in 1873, was far behind the scientific instincts of the present century. Here, the funeral pile consisted of a stack of wood, about 5 ft. square, pinned to the ground in a cradling of iron bars, and with a heap of loose wood thrown upon it and around it. The pile was also sprinkled with camphor and aromatic substances. The body was anointed with pure naphtha, and the limbs covered with resinous matters and strips of perfumed wood. It was then laid, at midnight, upon the pile, covered with more layers of wood, and the torch applied by the next of kin to the deceased prince. But, although the flame was fanned by a strong wind, the body was barely reduced at seven o'clock the next morning; and it was not until after the lapse of ten hours that the whole pile had been consumed, and the Indian priest could collect the ashes.

Some such treatment must have been followed out in classical times; and we argue this with the more reason when we find that, at the present day, in far-off India, the same simple procedure obtains. A bed is prepared, on rising ground, by levelling the earth, as long as a man with his arm extended above his head, a fathom wide, and a space deep—just as was prescribed in the ancient books—and on this bed is placed a layer of wood and dried dung, which is the commonest fuel. The body is then laid upon the pile and covered with fresh combustibles, and, finally, a thin layer of earth is laid upon the whole, and fire applied. The process lasts about twelve hours. The fire is allowed to char and smoulder, away from the free access of air, till all the heap becomes a glowing and red-hot mass; and, when it is evident the fire has thoroughly penetrated the pile, it is stirred up with a pole, and the air being admitted, a fierce fire results, which speedily reduces the body to

* See "Cremation, its History and Bearings on Public Health." Smith, Elder, and Co., London.

ashes. Among the higher classes of Hindoos much the same practice is followed, and the chief difference lies in the greater costliness of the fuel, sandal wood largely replacing the ordinary firing, and cocoa-nut oil being from time to time sprinkled over the pyre. The burial service recited over a Brahmin, I may mention in passing, is very poetical. Earth is called upon to receive the body, as of it he was formed and sustained, and to it again returns. Fire, which had a claim on the deceased, and by whose influence in nature he subsisted, is asked as an emblem to purify it on entering a new state of existence. Air, which he respired, is besought to receive him, now his last breath is departed; and Water, which contributed to his life, and which was one of his sustaining elements, is also entreated, now that his remains are being dispersed, to receive its share of him who has taken an everlasting flight.

The re-establishment of cremation having been considered a wise proceeding by Professor Brunetti, discarding for once and all the idea of reverting to the ancient pyre, he cast about for some device which should be an improvement upon it, and which should embody some of the resources of modern science. The result was the crematory, the original model of which I here exhibit, and which may have been seen by some now present at the last Vienna Exhibition. It is rudely constructed, but its structure will easily be apparent. The furnace is of fire-bricks, or even of common bricks placed upon the ground, and at the upper part of its faces, by means of bricks laid flat, a projection is formed which is intended to support the reverberatory apparatus. Ten openings allow of the fire beneath being suitably directed, and its violence also modified if necessary. The plate which receives the body is sufficiently thin not to retard the passage of the heat.

In using this apparatus, a small pile of wood is first of all arranged in the crematory, the length of the body, and the height of the support, which latter is made portable. When the wood has been placed in such wise as readily to kindle, the support is placed within the walls, but not so as to touch them in any way, and the body is placed upon it. The pile is then lighted, and at the end of half an hour the body flames. It is only during this period, says the professor, that certain gases which had not yet sufficiently combusted disengage themselves. It is necessary now to slightly separate the parts of the apparatus which cover the body; but this requires but slight labour. The conflagration of the body over, which the professor calls the first stage of cremation, the second period commences, or what he terms the period of spontaneous combustion, during which the fire attacks the muscles, and a complete carbonisation takes place. The third stage is now reached, when the incineration of the soft parts and the calcination of the bones take place; and it is now found necessary to collect the carbonised mass together and concentrate it upon a third part of the support. The sustaining ironwork is lowered upon the support, as much as possible, so as to economise the heat. When this has been done fresh wood is added, the registers removed, and very shortly afterwards complete calcination is achieved, and the crematory left to cool, so that the ashes can be collected.

With such an apparatus as above described, Professor Brunetti conducted at least three perfect cremations at Padua, besides many experiments.

Date.	Sex.	Age.	Weight of Body.	Weight of Ashes	Time.	Cost of Fuel.
		Years.	lbs.	lbs.	Hours	s. d.
March 10, 1869 .	Female.	35	116	6·00	$3\frac{1}{2}$	3 0
January 20, 1870.	Male.	45	99	3·06		
May 15, 1870......	Male.	50	90	4·06		

It is not, however, likely that use will be made of this mode of cremation again, as already great improvements have been made in Italy in this direction. The professor, in a pamphlet published in November last, a copy of which he sent me, admits as much with the greatest frankness. He says he aimed at simplicity, and thought that four brick walls and two reverberators of plate-iron, to concentrate the flames upon the body, was quite sufficient. Certainly it was sufficient to obtain the most complete incineration of the soft textures, and the most complete calcination of the bones. No other crematory has succeeded in giving better results, and the ashes and bone earth were of a delicate white. Still it did not, he thought, perhaps meet the artistic and religious exigencies of the rite, and he has now relinquished his pet "adamitie" apparatus, as he terms it, in favour of one of Professor Gorini's which I shall shortly describe. The one great objection to Professor Brunetti's system was the want of a flue wherein to collect and destroy the gases evolved during combustion. The cremations were also performed out in the open air. The site chosen was in the centre of a spacious yard belonging to a deserted barracks, and the flames during the second part of the spontaneous combustion of the body were considerable. I may add, by the way, that, though this was so, the management of the cremation was such that at no time did the air become polluted.

The prize which was accorded to Professor Brunetti, and a further one which was offered for a still more complete and scientific apparatus, as well as a laudable striving after improvement, generally, induced Professors Polli and Clericetti to bring into public notice their device for a crematorium, and this was built at the expense of the Keller family upon a piece of cemetery ground granted by the municipality of Milan. The building is about 40 feet by 32 feet, classical in treatment, and was built of stone brought from Verona. The first cremation was that of the noble founder of the pile, and the body was conveyed to it upon a funeral car, and after the religious ceremony, and an address by Professor Colletti and Dr. Pini, the body was placed in the crematory chamber, and an hour and a half sufficed to reduce it. The ceremony was attended by a concourse of notables, and on the following day the ashes were removed to the cinerary urn and placed in the family chapel. I may mention here that as a rule the ashes are taken to the mortuary chapel, where the performance of cremation is formally verified, after which the attendants place them in a vase which is sealed with hydraulic cement, and is finally deposited

in a compartment of the ossuary, the latter being closed by a marble slab.

The Polli-Clericetti apparatus presents the appearance of a sarcophagus, as you will observe by the model before you, which was sent to me for examination by the Cremation Society of Milan. Its form conceals that of the crematory chamber, which is within, and extends its entire length. The chamber inside nowhere touches the external part, and the air circulates freely in the surrounding space, in order to keep the surface of the sarcophagus cool, no matter what may be the temperature of the internal chamber. The furnace consists of a built-up casement formed by two longitudinally parallel walls, and these support the crematory chamber, which is composed of double vaults, so to speak, the interior one formed of refractive material, protected outwardly with sheet iron, and the external one concentric with the first, of ordinary brickwork. The two arches are firmly held together with girders of iron. The internal chamber constitutes the true furnace of the apparatus, and it contains the grating upon which the body has to be placed, all the flame jets, and the plate upon which the ashes fall. The grating is of iron and supports a series of small bars laid transversely side by side. These bars are supported in the simplest fashion, in order that they may freely expand in the heat. The grating is kept in position by small iron pulley, which serve to raise and lower it as required. Below the grating is seen the ash-plate, intended to receive the ashes and the minute particles of the body which fall through during combustion. This is also sustained by iron pulley and removable from the apparatus.

The fire is formed of 217 jets of flame, produced by the mixture of gas and air. Of these, 180 jets are disposed in a horizontal plane below the grating and between it and the plate for the ashes, and constitute a bed of flame formed by 18 transverse rows, each consisting of 10 jets. The remaining 37 are placed above the grating, distributed in two rows of 18 each, running longitudinally right and left along the impost of the inner vault, besides another corresponding with the extreme end of the apparatus, which is directed towards the head of the body to be burnt. All the 37 jets mentioned have an oblique direction. For the lighting of the apparatus there is provided a small tube, pierced with holes. These small flames, destined to light all the others, are to be lighted an instant before introducing the body. Another series of 80 jets of gas are distributed in three parallel rows, and placed below the ash-plate to keep it hot enough to rapidly evaporate or burn up any liquids which may fall from the body in combustion. Besides the compressed air injected, which feeds each flame at the moment of its admixture with the gas, the furnace also receives the external air by means of an air conduit from the gas-house. It enters at the bottom of the inner rectangular chamber, and, traversing it to a perforated table which forms its floor, is equally diffused below the grating. The underground conduit is there furnished with a shutter, placed between the gas-house in proximity with the general conductor, in such a way that it can be regulated at pleasure.

Three cremations have taken place in the above gas-using crematorium.

Date.	Sex.	Age.	Weight of Body	Weight of Ashes	Time.	Cost of Fuel.
		Years.	lbs.	lbs.	Hours	
January 22, 1876	Male	73	117	6·43	1½	75s.
March 24, ,,	Female	44	109	6·15	2	
April 17, ,,	Male	71	96	8·26	2½	

It is an ungracious task, at any time, to criticise, and above all, to find fault with a scheme which has been voluntarily submitted to your notice by distant friends, but I am obliged to tell my audience that this system of cremation cannot be advocated. It is not an economical application of gas as fuel. Several professors of medicine and councillors who were deputed by the Provincial Sanitary Council of Milan to watch and report upon the second cremation which I read from the list, and which took place in the Polli-Clericetti crematory, have formulated several objections which I will briefly notice. After minutely describing the details of the process, these gentlemen arrive at the conclusion that the apparatus in question does not fully attain the true object of cremation, which is the reduction of the remains to a state which shall no longer be subject to change of any kind by atmospheric action, in fact, a perfect incineration of the organic substances. They remark that whilst carbonaceous relics exist, the organic portions have not undergone complete combustion. Some fibrous structure was noticed by them to remain after an experiment made upon the body of one of the lower animals, and they express a doubt whether complete cremation can ever be obtained by the direct application of such flame. They also point out the inconvenience of having at times to collect the remains in three different places, on the grating, amid the jets, and in the ash receptacle. In short, they finally express their opinion that the system is susceptible of very considerable modification and improvement, and politely express a hope that a success may still follow the labours of the inventors.

Another Italian crematory, in which seven human cremations took place during last year is known as the Terruzzi-Betti apparatus, but I have, unfortunately, not been able to obtain a loan of the model belonging to these gentlemen. A drawing and explanation of it may, however, be seen on the wall before you, and can afterwards be examined by those who are interested. Here the crematory chamber is formed of a refractory material, and when this is properly heated the coffin containing the body is introduced, and the doors are shut. The aqueous vapours are conducted into the midst of the fire where all those principles which might be noxious to general health, are destroyed without any odorous exhalation being perceptible. This first part of the cremation being over, the combustion is begun, and the illuminating gas produced is led by a special contrivance beneath the crematory coffin, where it takes light, and serves as an assisting combustible, thus combining, as the inventors claim, hygiene, simplicity, and economy. When the gas ceases to flow from the special tube, it is an indication that the body is carbonised, and that the first part of the cremation is finished. During the second stage of reduction the doors are unclosed, the disc taken from the crematory coffin, and the doors again shut, whereupon the air which enters by the

opening of the ashpit passes directly into the coffin, and the real incineration of the body immediately commences, and is more or less quickly completed.

I now give a list of the cremations which have taken place at Milan with this apparatus, and which I am enabled to do by the kindness of Professor Pini:—

Date.	Sex.	Age.	Weight of Body	Weight of Ashes	Time.	Cost of Fuel.	
		Years.	lbs.	lbs.	Hours	s.	d.
March 29, 1877..	Female.	31	$80\frac{1}{2}$	4·40	$2\frac{1}{2}$	6	3
April 1, ,, ..	Female.	19	...	...	4	6	3
August 25, ,, .	Male.	42	...	.	5	8	4
Sept. 5, ,, ..	Male.	28	77	3·96	2	6	3
Sept. 13, ,, ..	Male.	34	...	...	$2\frac{1}{2}$	6	3
		Months.					
Dec. 3, ,, ...	Male.	13	$18\frac{3}{4}$	0·77	2	5	5
		Years.					
Dec. 24, ,, ...	Male.	22	...	...	$5\frac{1}{2}$	...	

As might be expected, the above system of cremation has been subjected to a great deal of criticism, and the chief attack upon it is made by Dr. Brunetti, of Padua, of whom I have before spoken. He considers that they start upon an erroneous principle; that their apparatus—which burns coke and wood in the proportion in weight of four-fifths of the former to one-fifth of the latter—is hardly to be called a crematory, but rather an ordinary coke retort. He admits that they arrive at a kind of incineration, but that the result is a black cindery mass, sufficiently calcined on the outer layers, but far from presenting the clear white colour proper to duly calcined bone, and very different to the sample before you, which has been kindly lent to me by Sir Henry Thompson, and which represents the remains of an animal that weighed, previous to reduction by him, 47 lbs. avoirdupois. He considers that the fire in cremation should act directly upon the body, and not through another medium, as in this system, otherwise no due regard can be had to the combined economy of time and expense. He furthermore declares that where there is a strong draught in the chamber, during the extremity of incandescence, and when the bony matter is exceedingly friable, the current will detach the minuter particles, and cause them to disappear in the form of sparks. And he concludes his remarks, which were only published a month or two ago, by saying that the time and money expended, with an incomplete reduction after all, are no longer permissible by the laws which ought to govern cremation.

I now approach the subject of Professor Gorini's crematory, which is constructed on an entirely different principle, and which has been declared the best possible system extant where wood is used as the combustible. I have been intrusted with the original and beautiful model which is before you, and will now proceed to make a few remarks upon its working. A working drawing of this crematory can be seen on the wall.

The crematorium of Cavalier and Professor Paolo Gorini is situated in the centre of the cemetery of Lodi, and is known as the *Crematorio Lodigiano*, as the professor, who is an adopted citizen of Lodi, wished, by this name, to attest his gratitude. It is constructed of common bricks inside, and the whole cost of its erection, including the metal parts, did not exceed £120 sterling. It may be likened, Professor Brunetti says, to the boiler of a steam-engine, where there is a box for the combustibles, a boiler, and the chimney all combined, only that in the Gorini crematorium the flame is drawn by the current of air into the chamber instead of the tubes of the boiler. Its appearance leads the spectator to imagine that the chamber is somewhat too large, but the inventor has successfully proved that this is not so. He desired to conduct the gases developed from the combustion of the body into the chamber, promoting the development of such gases, but burning them progressively. He does not use solid wood or gas, but the commonest refuse of wood, brushwood, and twigs of branches, and the like. He even proposes to make use of the dried herbage of the marshes, and he says, also, that the woody part of hemp, common in Bologna, would be very serviceable for his purpose, and reduce the cost of a cremation to a few halfpence. Hence he has need of a large combustion chamber. The floor of the chamber is formed by a grating of cast-iron, and under this, on the ground itself, there is placed an ash reservoir, furnished with a proper opening, in case it was required. The flame from the combustion chamber is led into the crematory proper, through a large opening, and when the body is disposed in the chamber, the reducing medium, fire, easily surrounds it.

There is a certain peculiarity in the construction of the chimney, the base of which is about five feet from the crematorium, and this consists of an opening at the foot, leading to a channel which descends vertically for a certain depth, then runs horizontally somewhat to the left of the stack, then ascends to the height of about five feet from the ground becomes then horizontal, running somewhat to the right, and finally takes the direction of the chimney, which is about 32 feet high. The flame, on ascending from the furnace, enters the crematory chamber horizontally, envelopes the body equally in every direction, and, passing to the end, descends under ground, progresses horizontally, ascends, turns horizontally again, and finally ascends anew, to issue from the chimney, having traversed in this way a course of about 58 feet from the chamber, when the combustibles are burnt and the flame generated. These angular passages are substituted for the balls of chalk which he placed in his first crematory, and which were intended to arrest the soot. The inventor also constructed a small furnace in the base of the shaft, to consume the smoke, but he has never required to make any use of it. An important feature in the Gorini apparatus is seen in a channel of refractory material, which runs along the wall until it enters the chimney. By means of this deviating channel the flame can be diverted from the crematory chamber, and driven direct into the base of the chimney.

Whatever my hearers may think of a purely technical description, such as the foregoing, they would do an injustice to the rite of cremation, did they not realise with what perfect solemnity and decorum all this can be and is conducted. The

attendant, when all is ready and the body has been decorously placed, closes the crematorium at both ends, as well as the communication between it and the shaft, and the body is thus isolated and in privacy. The firewood is then lighted, not under the body, as in the other systems, but in its own portion of the apparatus; and a few minutes afterwards the attendant opens the two communications, and closes the deviating channel. The flame, when permitted to be seen, is noticed to be at first vivid and transparent, and takes afterwards a pale hue. In about an hour's time, when the combustible substances of the body are entirely consumed, the flame again becomes transparent, and the incineration of the tissues and the calcination of the bones commence. Finally, and within two hours, at the expense of three shillings, the cremation is complete, and the ashes are collected from the grating, &c., into an urn. And during the whole of the ceremony the most careful critic can detect no nuisance or odour, or anything appertaining to irreverence.

The cremations which have taken place in the Lodi apparatus, erected by Professor Gorini, are six in number, and were conducted between September and November of last year.

Date.	Sex.	Age.	Weight of Body.	Weight of Ashes	Time	Cost of fuel.
1877.			lbs.	lbs.	Hours	s d.
September 6	Male.	45	$92\frac{3}{4}$	5 29	$2\frac{1}{4}$	2 6
September 14 ...	Male.	63	109	5·51	2	2 4
September 27 ...	Male.	60	143	5·95	$2\frac{1}{4}$	2 6
October 8	Male.	60	105	5·84	$2\frac{1}{4}$	2 5
October 22.........	Male.	47	114	5 73	$2\frac{1}{3}$	2 7
November 15.....	Male.	50	87	4·07	$2\frac{1}{4}$	2 5

I may, therefore, confidently claim for Professor Gorini that he has proved beyond doubt that the rite can be respectfully, speedily, and economically carried out, and that he deserves the thanks of all those who wish success to this mode of disposal of the body. The professor is about erecting a still more improved crematory in Milan, and doubtless others will quickly arise in the various cemeteries of Italy. The professor has also solved the problem of burning several bodies at a time in the one chamber, which is secured by passing the flame into a second crematory chamber instead of into the tortuous passage underground. But a thorough description of how this is achieved would, perhaps, weary you.

I may here add that the Lodi crematorium was erected by the Communal Council of that city, and that the municipal engineer reports to this body regularly whenever a cremation takes place. The Syndic, in the name of the Junta, has also formally communicated an official document to Professor Gorini complimenting him upon the success of his scheme.

I have now described to you the various systems which have been in vogue in Italy during late cremations, and also explained, as fully as the time will permit, the pattern of crematory which is certain to be adopted generally throughout that country. Before I commence to deal with the improved systems of cremation, having an admixture of gas and air as fuel, by which I mean the system practised by Messrs. Siemens and others—and which system is already adopted in Germany, and must surely triumph with us in England—I should wish to say a few words as to the practice followed out in America.

In the United States, strange to say, the rite of cremation is still practised among the aboriginal Indians, at least, according to Professor Le Conte, who witnessed a cremation amongst the Cocopa people, on the Colorado river. They burnt the body on logs of mezquite wood, which is known to yield a maximum of heat with a minimum of flame and smoke. A few personal effects of the deceased were added to the faggots, the fire was lighted, and, after some kind of invocations and prayers to some deity for the happiness of the soul of the deceased, fresh wood was added until all was consumed, in about three hours' time. It is not, however, of these ancient world practices that I desire to allude, but, rather, to the system chosen by the educated citizens of the present day. Everything seems to indicate that cremation will shortly reign paramount in several States, and that only an impulse is wanted from Europe to fairly inaugurate the reform. Up to the present, only three recorded modern cremations have taken place; one being that of Henry Laurens, the first President of the American Congress; the next, that of George Opdyks; and the third, that of Baron de Palm, aged 76, on the 6th December, 1876. In each case an ordinary form of retort was chosen, and it is likely that the Americans will contrive to improve, and will retain, this form of crematory apparatus. A huge crematory of this description was designed not long ago for India. It was pentagon-shaped, and series of cremations could take place at the same time, a separate wing being reserved for the Brahmins. I draw your attention to an elevation of this, upon the wall behind me. Professor Frazer, writing in the *Penn Monthly* in 1874, says, even, that an economical plan would be to associate a crematory with the large iron furnaces; but that is not suggested seriously. He thinks, rather, that, if the practice became general, reverberatory funeral altars would be erected in convenient places, wherever the death-rate would justify the outlay. He calculates that five crematoria for each State and Territory, or about 193 in all, could suffice to burn the 810,000 persons who die annually in the United States; but that, as the people are unduly scattered, probably ten times that number would be wanted. He thinks, also, that the expenditure of fuel per body would be 176 lbs., at 60 cents, and that an hour might be reckoned as the duration of the incineration. All this is, however, largely in excess of what would be required.

The cremation of the body of Baron de Palm took place in a building erected for the public use, at the expense of Dr. Le Moyne, in the town of Washington, Pennsylvania. Two photographs of the building and the means employed for the reduction was kindly forwarded to me by Dr. Le Moyne, and I here exhibit them. The building is 30 feet by 20 feet, erected on stone foundations, very substantially built, and nearly fire-proof, and is roofed with galvanised sheet iron. It is unpretending in appearance, but it is situated in the most lovely position, and it is visited by hundreds of persons in the year, who evince the greatest interest

in the matter. The crematory chamber is a fire-clay retort, large enough and of the proper shape to receive an iron receptacle, the proportion of a coffin, made of small round rods about eight inches deep, with feet, two or three inches long, to keep the body that height from the bottom of the retort, and so permit a free access of air underneath the body. In the back of the upper part of the retort is a four-inch opening to permit the escape of the gases and fumes from the burning body to pass into the red-hot fire-clay brick flues, which surround the retort both longitudinally and transversely. By this means all smoke and odour is destroyed before they reach the chimney. The doctor informs me that he found it necessary to admit external air through the lid of the retort, so as to prevent coking or charring the body, and this also hastens the process of calcination in the bony structures. The aperture in the lid is fitted with a sliding valve, in order to regulate the quantity of admitted air. Since the first cremation he has also added a hand-blower, so as to increase the vigour of the furnace and so shorten the operation. Although 80 years of age, Dr. Le Moyne is still busy in trying to improve the apparatus. The direct outlay for the cremation was forty bushels of coke at 2d. per bushel, and 34 hours' labour at 8d. per hour, which is something under 30s., and the cremation was completed in about two hours. The cost of the entire structure, including reception-room, colunbarium, and retort, was £300.

I pause here for a moment, before proceeding to a description of the German and English crematoria, in order to express a regret that those who have witnessed a cremation, in modern times, should have given highly sensational descriptions and reports in some of our newspapers. This disregard of propriety in dealing with the matter, and in carrying out the last testament of the deceased, has never, to my knowledge, occurred, save in newspapers published in England and America. A lamentable breach of good taste in this respect can be seen in a copy of the *North Wales Chronicle* of December 30, 1876, and in various American papers of the same month, in which is described the cremation of Baron de Palm. It was not from the pen of an English journalist, I am thankful to say, and I am sure that no reporter in this country would pander to morbid tastes in this manner. The issuing of these reports in the American press decided Dr. Le Moyne to forbid any more cremations in the building erected by him, although many applications have been made to him for its use, and he declares that he will wait until a more healthy tone of mind sets in with the community. Abroad, there is of this unhealthy curiosity nothing whatever, and it is possible there to read in the daily journals scientific accounts of a cremation, duly attested by the proper sanitary authorities, which have nothing sensational in them, and which can be perused even by those opposed to the ceremony without any sense of mental discomfort.

The apparatus chosen by the authorities in Germany, for use there, is the Siemens pattern, a model of which has been sent to me by Mr. F. Siemens, of Dresden, upon whose premises two human cremations have been conducted. The model is beautifully constructed, as all will observe; but to render the procedure still more familiar to my audience I have made a diagram in section of the apparatus. This kind of crematory is so constructed as to heat the developed gases to the proper degree, which will cause them to burn with a luminous flame when they come in contact with atmospheric air. Nothing can escape from the chimney which can prove to be in the slightest degree offensive. In June last, I witnessed a cremation in this apparatus at Dresden, and although the experiment was attended by some of the most acute observers from many parts of Germany, Holland, Russia, and France, nothing of a disagreeable character occurred. When the body of a horse, weighing 460 lbs, was consumed in the same kind of chamber some months previously, the gases in the flue were intercepted by an aspirator and found perfectly inodorous. For the rest, the ashes are delivered in a beautifully white condition. The success of the system has been so great that it has already been chosen in Holland and Switzerland for use in those countries.

This German pattern (p. 237) consists of a combustion chamber, C, with a grate of fire bricks, of the ash-pit, D, with a flue, E, leading from the same to the chimney of the regenerator, B, and a gas producer of ordinary construction, which is not, however, shown on the drawing. Under the regenerator, B, two channels marked A will be seen, of which the lower conveys gas and the upper atmospheric air to the apparatus. The regenerator consists of fire bricks so arranged as to leave numerous passages between them, and so present a large surface to the flames or to the air passing through. A short flue at the top causes it to communicate with the combustion chamber. When the regenerator and the combustion chamber have been heated to a bright red heat by the air and the gas in a state of ignition, the gas is shut off, and the body introduced upon the longitudinal ridges which form part of the grate. The door is then closed, and air only introduced by way of the air channel to the regenerator, and the heated air ignites the body and supports the combustion to such an extent that in an hour's time the whole of the remains, viz., the ashes and calcined bones, fall into the ash receptacle below. In the building for a crematorium, designed for a population of 200,000, Messrs. Pieper and Lilienthal, the ashes, on the withdrawal of a slide by the attendant official, drop immediately into the urn.

Three cremations have been carried out by means of this type of Siemens apparatus.

Date.	Sex.	Age.	Weight of Body.	Weight of Ashes	Time.	Cost.
1874.			lbs.	lbs.	Hours	s. d.
September 22 ...	Female.	Aged.	70	3·00	$1\frac{1}{6}$	3 0
October 9	Female.	26	...	3·75	$1\frac{1}{4}$	...
November 6	Female.	23	...	4·00	$1\frac{1}{2}$	...

The Council of the Cremation Society of England* have chosen the same kind of apparatus for use in any building to be erected under their auspices. But the pattern they have fixed upon is that of Dr.

* A metropolitan branch of this society has been formed, Mr. D. McDonald, secretary, at 46, Lincoln's-inn fields. Subscription half-a-crown yearly. The transactions and rules of the parent society are published by Messrs. Smith, Elder, and Co., London, price 1s. Plans and sections, and a complete bibliography is there given.

C. W. Siemens, which is more complete and more suited to a large population. Dr. Siemens very generously, at the request of the Council, presented the Society with complete working drawings of his patent regenerative gas furnace as arranged for cremation, which can be seen on the wall, as well as specifications and estimates, and a crematory would have long ago been in operation upon a site in the Great Northern Cemetery, which was granted to the Council by the proprietors, had not its erection on consecrated precincts been forbidden by the late Bishop of Rochester. I have no doubt that on some future day the proffered subscriptions, amounting to some £1,500, will once more be forthcoming, and that a crematorium, suited to the size of the metropolitan counties, will be ere long erected in some rural grove, on consecrated or unconsecrated ground.

The thorough equipment for this site, which was designed by Dr. Siemens –but which could not be erected under a large sum, or economically worked for infrequently recurring cremations, is without doubt the most complete one possible, and next to it ranks the arrangement used at Dresden and Breslau, and designed by Mr. F. Siemens, his accomplished brother, a resident in the former city. I do not think it needful to explain further the Siemens pattern of furnace, as it is now of world-wide celebrity, and its adaptability for cremation purposes has been so well described by Sir H. Thompson and others. I therefore merely exhibit a drawing of another crematory suitable for a city where cremation would be an every-day practice. The question, however, arises, whether a small community would be justified in the erection of so complete and so extensive an establishment unless well assured of support, and this has led me to recommend for use, under such circumstances, the automatic gas furnace patented by Mr. Rickman, and which I have seen in use at the Falcon glass-works, London. One thing is quite certain, and that is in this apparatus there can be produced a greater intensity of heat than can possibly be required for any existing operation in the Arts and Manufactures. As much as 3,500° Fahr. have been obtained, which is a heat capable of melting ordinary Stourbridge fire-clay into the form of a black glass. Such a heat as this would not, of course, be required for a cremation, but one ranging between 1,500° or 2,500°, or such a dull red or yellowish white heat as the figures imply, and in this heat all compound organic gases would instantly be decomposed into their elements, and rendered inodorous and harmless.

The Rickman Arrangement.

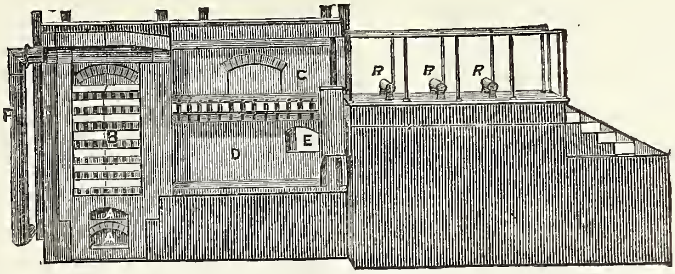
This form of cremation apparatus is shown on the diagram before you. The furnace, as may be seen, is simple in construction, and very easy of manipulation. The fire is laid in the ordinary manner, and the coal-box filled up, and as soon as the fire has burnt to the top of the bars it is in full operation. If there be no excess of gas made, it ignites on issuing through the throat of the furnace, but if there be, then all that is necessary for perfect combustion is to slightly open the air-flues and introduce a quantity of air. During the cremation, the air-flues which lead to the cremation chamber will also require to be opened, to admit air, by means of which the gases produced there may be oxidised as well as decomposed by the heat. The mechanical part of the cremation would be simplicity itself. For instance, as in the Siemens system, the body being deposited in the chapel, and the funeral service being read to a certain point, the door of the crypt would open, and the coffin slide upon the lift, the carriage on the lift having been previously raised to the level of the chapel floor. The coffin would then descend upon the carriage to the door of the cremation chamber, which would open to receive it, whereupon it would be run into the chamber and deposited there, the carriage withdrawn, and the doors closed. The whole proceeding would be at once simple, decorous, and economical. Before the ordinary service closed, or before a very little extra time could have elapsed, the ashes would be inurned. As for the economy of this pattern of crematory that cannot be questioned. The coal-box would have a capacity of 8,000 cubic inches only, and $1\frac{3}{4}$ cwt. of coal would last for six hours. The cost of a crematorium erected on this system would cost about £100, as against say £500 for a German Siemens, or £1,000 for an English Siemens crematorium. But, as I have been careful to point out, the Rickman apparatus, constructed by Mr. Baynes Thompson, is selected by me for use where cremations would not be frequent. To these figures the cost of some suitable building would require to be added in each case.

I feel constrained to ask for pardon at the hands of Professor Gorini, and his most esteemed colleagues, for having, after mature deliberation, felt compelled to prefer the Siemens or the Rickman gas and hot air systems of cremation to those which have acquired such renown with them in Italy, and which may still further be improved; but I think it will be taken for granted that, with our class of combustible, no other system is possible here. Moreover, the uniformity of the results obtained by the Siemens furnace is very remarkable, as will be seen by the following table:—

Place of Cremation.	Subject.	Weight of Bodies.	Weight of Ashes.	Time.	Experiments Conducted by
		lbs.	lbs.	Minutes	
London	Pig.	47	1·75	25	Sir H. Thompson
,, ...	,,	144	4·00	50	Ditto.
Birmingham	,,	227	5 00	55	Ditto.
Dresden	Horse.	202	16·00	...	Prof. Reclam.
,, ...	,,	460	23·00	210	F. Siemens.
,, ...	Dogs, &c.	99	3·20	30	Ditto.

I have now concluded the task which I set before myself, but I feel that the way in which I have performed it is not entirely worthy of the subject. I have only to express thus publicly—and through a world-wide medium, which they will be sure to see, the *Journal* of this Society—my thanks to Mr. Frederick Siemens, of Dresden, to Professors Brunetti, Polli, Clericetti, Gorini, and Pini, of Padua, Lodi, and Milan, for the loan of the beautiful models before you, and to Professors Kinkel, of Zurich, Reclam, of Liepzic, Hoogewerff, of Rotterdam, and Dr. Küchenmeister, Dr. Jannasch, and Baron Stockhausen, of Dresden, for the kindness which they have shown to their English colleague whilst engaged in collecting the materials of this paper.

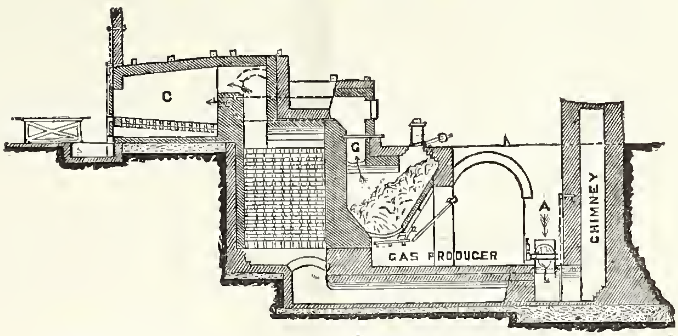
The Gas and Air Systems of Crematoria.



Longitudinal Section.

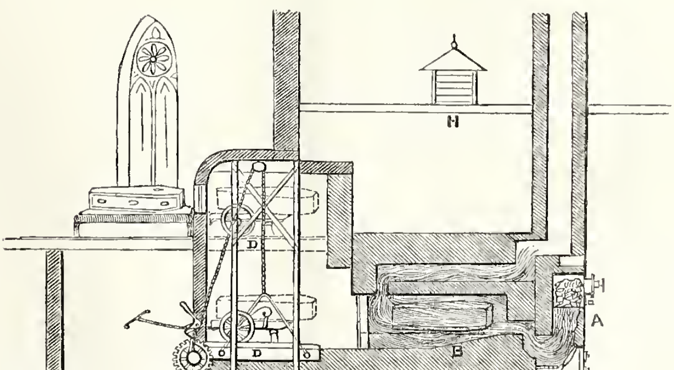
A A, channels for conveying gas and air respectively to the apparatus when at first heated; B, regenerative apparatus; C, cremation chamber; D, ashpit; E, flue leading from ashpit to chimney; F, tube for supplying gas to the chamber C during combustion, if necessary; R, rollers for introduction of coffin.

The German Pattern (F. Siemens).



Longitudinal Section of the Siemens Patent Regenerative Apparatus.
C, cremation chamber; G, exit for gas.

The English Pattern (Dr. Siemens).



Longitudinal Section.

DISCUSSION.

Mr. Phillips Day said he did not desire to say a word to condemn the process which had been so powerfully recommended by Mr. Eassie, but he still thought he had been rather too sanguine. He fully believed that cremation was a sanitary and excellent system, and had gone so far as to advocate it in a small treatise, but still there were three great barriers, it appeared to him, which would stand in the way of its adoption. The first was the clergy, the second the undertakers, and the third, public prejudice. The question was what was to be done under the circumstance, in the terrible condition of our large cities, with cemeteries close to them, with fetid remains in the cemeteries, and too often polluting the water and the air. Something must be done, and done quickly, to avoid the complete destruction of the public health. The system of burial at present in vogue was, to his mind, most shocking in its details, especially when carried on in the neighbhourhood of large cities, and he believed the most practical and efficient method of avoiding these evils was that advocated by an eminent surgeon, Mr. Seymour Haden, of "Earth to Earth" burial; in other words, the burial of bodies without the intervention of an impervious coffin, and away from cities. In looking over a treatise of Aristotle's, he had lately noticed something corroborative of Mr. Haden's views, and it struck him that this system was the most economical and most agreeable to public prejudices, pending the time when the still more sanitary method of cremation could be adopted.

The Chairman having reminded the meeting that the subject of discussion was cremation, and not other modes of disposing of the dead,

Dr. H. C. Bartlett said—Altogether agreeing with the general scope of the valuable paper just read, I feel assured that the gas arrangement of MM. Polli and Clericetti is susceptible of an extension and improvement which is not obvious in their model, or suggested in the details explained. If their 317 gas jets are protected by tuyeres, the gas and air may be delivered combined in the proper proportions to form a series of large Bunsen burners. Moreover, both the gas and the air, so used, may be previously heated by each supply pipe, in a coiled form, being subjected to the flame of other large Bunsen burners. The combined air and gas, so heated, give an intensity of calorific power which exceeds every other gas furnace. For the last 20 years I have used a combustion furnace of this kind, and I find it economical to the last degree, and that it consumes all noxious vapours, and, therefore, I suggest that a sufficiently high temperature be given to the gas and air before issuing from the jets. This will render M.M. Polli and Clericetti's form of crematory apparatus one of the least expensive to work, and will probably prove more easily and generally available than any other yet described. In my opinion, nothing less than the immediate cremation of persons and animals dying of contagious and infectious diseases will render the disposal of such bodies satisfactory in a sanitary sense. In certain soils, which are to be found in many parts of this country, burial without cremation is to ensure the pollution of earth, air, and water whenever an interment is permitted. But, when death has resulted from infectious disease, such pollution must be considered as criminal.

Mr. Hale did not think either the clergy or undertakers ought to be allowed to stand in the way of a public improvement, and regretted that the other obstacle mentioned, public prejudice, had not been to some extent dealt with in the paper. There was certainly ono advantage in cremation, that no body could be buried alive.

In reply to a question how the remains of the dead could be separated from the ashes of the fuel,

Mr. Eassie said such a mixture could only occur in the primitive modes of cremation which he had first referred to, and which no one now advocated. Where several bodies were disposed of alone, each was provided with a separate chamber.

The Chairman, in proposing a vote of thanks to Mr. Eassie for his instructive and elaborate paper, said he must join with him in saying that the accounts which had been given in some of the public prints of the process of cremation had been entirely uncalled for. They might as well exhume a dead body at the end of several months, and describe the state it was in, as to pourtray what the body underwent during the process of cremation. He presumed when the corpse was put into the chamber where it was to be burned, it would be sealed up until the whole process was complete, and it was a most culpable curiosity to examine what went on during the interval. He had been an advocate of cremation for many years. When quite a young man he thought the method most in accordance with sanitary principles for disposing of our mortal coil when we had shuffled it off, but he never mentioned his opinions to any one, fearing they would be received with abhorrence. He was therefore much pleased when he saw it announced that a society had been formed for encouraging this practice, and quickly enrolled his name amongst the members; and he did so with the greater pleasure when he found amongst their ranks so distinguished a scientific man as the gentleman who kindly allowed them to hold their consultations in his house. As far as the physical difficulties went, he did not think they were now very great, but a greater difficulty lay in the prejudices of the public. He trusted, however, that if they brought this subject forward from time to time, those prejudices would wear out, and that they might at length see the process carried out, which, with our rapidly-increasing population, was most desirable. He hoped that none who were either indifferent or opposed to this movement would stigmatise them as freethinkers for advocating cremation. He could only say for himself, that he was a firm believer in the doctrines of Christianity, and should regard the idea of cremation with abhorrence if he thought it was at all opposed to the religion he professed.

The vote of thanks having been passed unanimously,

Mr. Eassie briefly acknowledged the compliment, and the meeting adjourned.

CONGRESS ON DOMESTIC ECONOMY.

A meeting of the Executive, Ladies, and Finance Local Committees, who are co-operating with the Society of Arts in making arrangements for the approaching Domestic Economy Congress in Manchester, was held at the Town-hall, on Thursday, the 7th inst., the Bishop of Manchester presiding. Amongst those present were the Bishop of Salford, the Dean of Manchester, Dr. Maclaren, the Rev. Mr. Steinthal, Mr. Oliver Heywood; and amongst the ladies, Mrs. Cowie, Mrs. S. Fielden, Mrs. Roby, Mrs. C. P. Scott, Mrs. Dickens, Lady Cole, &c.

Sir Henry Cole, K.C.B., Vice-president of the Society of Arts, explained the objects for which these annual Congresses were being held by the Society of Arts, and described the proceedings at the first Congress held last yeer at Birmingham. A programme of proceedings sanctioned by the Society of Arts, was submitted, and

discussed in detail. The following programme, drawn up to meet local circumstances, was agreed to:—

Membership of the Congress.—Members of the Society of Arts as such are members of the Congress. Other members will be admitted, on payment of 10s., to the conversazione and meetings, and will be presented with a copy of the report of the Congress when published.

Conversazione.—The Congress will be opened with a conversazione on the evening of Wednesday, 5th June.

Papers will be prepared, printed, and circulated not less than a week before the Congress, to be used during the Congress. Each author of a paper will be allowed not more than ten minutes for reading the paper or stating its substance or arguments in its support. The papers must have strict reference to the modes of teaching the several subjects to be taught in elementary schools, and must not be treatises on the general subject. Persons desirous of preparing papers in any of the following subjects should inform the Secretary of the Society of Arts, John-street, Adelphi, London, W.C., or the Assistant-secretary to the Congress, Mr. F. Scott, 100, King-street, Manchester, as soon as possible, and the papers themselves should be sent in before 1st May, 1878, at latest.

Subjects of Papers.—1. Methods of Teaching the Subjects of Domestic Economy in Public Elementary Schools; also in Secondary Schools. Use of Diagrams and Models, and Objects. 2. Mode of Inspection and Administration of Government Grant for Teaching Domestic Economy. 3. Amendments of the Education Code necessary for enabling Domestic Economy to be effectively taught in Elementary Schools. 4. Establishment of a National College of Domestic Economy. 5. Importance of Female Inspectors. 6. Training of Domestic Servants, both Male and Female. 7. Health and Sickness. 8. The Dwelling—Warming and Ventilation. 9. Thrift. 10. Needlework—Clothing and its Materials. 11. Food and Cookery. 12. Cleanliness—Washing.

Regulations to guide the proceedings of the Congress were also approved. The business of the Congress will commence on Wednesday, the 6th June, at ten o'clock, and the sittings will extend in the mornings from ten to half-past one o'clock, and in the afternoons from two to half-past five o'clock.

MISCELLANEOUS.

EDUCATION IN INDIA.

The latest report upon the moral and material progress of India furnishes information upon the educational condition of the country. In Bengal, the policy of the Government is intended to foster pretty equally every kind of education, from the lowest to the highest. The annual expenditure amounts in all to rather over £400,000, of which £190,000 is contributed by the people, and somewhat more than one-half by the State.

The higher English education which leads to the entrance examination is that to which the people contribute the greatest share, namely, 70 per cent. of the total cost; to middle education, 63 per cent., or the same proportion as they pay towards female education; to middle vernacular education they contribute 55 per cent., and 46 per cent. to the primary. Of collegiate and special education the chief cost is borne by Government, the people's share being 42 per cent. for the former, and 21 per cent. for the latter. Of the total number of scholars, 71 per cent. were in primary schools, which rose in number during the years 1875-76 by 346, with an increase of 27,209 pupils. The increase was almost entirely in the new schools. In the primary schools, the principle of keeping the standard of instruction as low as possible was adhered to. This is intended to be done until the whole of the poorest classes shall have been brought under some kind of instruction. In the meantime, all who have time or means for learning more are encouraged to resort to schools of a better class. With this view an intermediate class of schools were established in 1875, ranking between the primary and middle class, and the success of these schools showed that their object was appreciated. The statistics of the middle-class schools went to prove that an education which includes some acquaintance with English is now more popular than that which is restricted to the vernacular.

The number of institutions in connection with the Government department in Madras rose from 9,151 to 10,236, and the number of scholars from 255,737 to 284,480. Twelve middle-class schools were added to the higher class, and a large number were transferred to the lower class. Elementary education being in a very backward state in this Presidency, the Government were devising measures for its promotion. In Bombay satisfactory progress was made. The total expenditure incurred by the Government was £239,654, of which £113,632 was granted from Imperial sources, and £71,833 was raised by a cess on the land revenue. The number of Government, aided, and inspected schools increased by 144, and the scholars by 12,026, the figures for the year being 4,478 and 250,712 respectively. The average daily attendance also increased from 177,547 to 186,834. Vernacular schools for boys and men numbered, at the end of the year, upwards of 400. The number of middle-class schools was 160, with about 17,000 scholars. In the higher and middle-class schools there were 9,593 boys learning English, or 259 more thon in the preceding year. The desire to learn English gives most sign of development in the capital itself. The number learning Latin rose from 242 to 282, and Persian from 757 to 885, while in regard to Sanskrit there was a falling off from 2,742 to 2,648. With a view to supplement the knowledge acquired in childhood, night schools are established in some of the larger villages. Of these there were 87, with 2,650 adult pupils. They are not, as a rule, reported on very favourably, but some of those in or near Bombay are stated to be useful to operatives of the cotton mills.

The number of Government institutions in the Punjab (exclusive of the University College) was 1,585, and of those receiving grants-in-aid, 480. The total number of schools on the books at the end of the year was 115,284 The question was under consideration of abolishing the Delhi College, and of utilising the savings for strengthening the staff of the college at Lahore, and for other educational improvements. It is said that the sons of the higher, and especially of the official classes, wish to learn English, and the insufficiency of tho teaching power of the college has hitherto been a difficulty in the way of meeting the demand. A school of industry and art was opened at Lahore during the year, the object of which is to convey to the native students such knowledge of painting and drawing as may assist them in their special trades, and especially to develop, by improved methods of workmanship, the native manufactures of India.

The information received regarding the state of education in the North-West Provinces during 1875-76 is very meagre. The attendance in Government colleges showed a considerable increase, and so did the number of candidates for the University examinations. The total number of schools in Oude increased by 49, and the scholars by 5,820. The pupils generally belonged to the higher castes. Satisfactory progress was made in the Central Provinces, and a sound foundation of primary education is stated to have been laid there. Besides larger numbers on the rolls, there was better attendance, and also improved scholarship in all classes of schools. With a view to giving to education a practical turn, industrial classes were established at the normal schools, whence those instructed would proceed

to village schools, and there open similar classes for imparting instruction to the villagers in the improved methods known at present only in the town. The addition of this element to the instruction given in village schools will, it is believed, render them much more popular, while it will certainly make them more useful.

In British Burmah there was a considerable advance in educational matters, and the aggregate of pupils attending the Government and missionary schools was 38,447, or 1·37per cent. of the population. The indigenous schools comprised 874 monastic and 255 lay institutions. The cause of education in the province is closely interwoven with the monastic order. The priesthood, with all the powers and privileges it confers, is no exclusive caste, but is open for ingress or egress to every orthodox believer. It prescribes no kind of asceticism, but only enjoins a life of purity, temperance, and truth. The work of national instruction was probably undertaken, not with any motives of influence, favour, or advancement, but with a view to qualify catechumens, or as a means of simple intellectual diversion. In course of time it came to be regarded as the peculiar function of the order, and lay schools, where both sexes are taught, were probably designed not to compete with but to complete the machinery of the monastic seminaries. Every Burman boy is brought up under the discipline and control of the village recluse. to whom the family authority is temporarily delegated. He is housed and clothed and fed in the school, and the parents are put to no trouble or expense throughout the whole period of his tuition. The master, as a rule, is strict and peremptory, yet sufficiently attentive to the moral and physical well-being of his pupils to earn their continuous attachment and esteem. His teaching aims at no high standard, and has a strong religious tinge. With all its defects, the system is ready at hand and is popular, effectually securing all the benefits of discipline, diligence, and habits of punctual attendance. It seems only natural that the teachers should regard with suspicion any foreign intrusion in their own domain, and should prove an actual obstruction in the way of any permanent want of progress. The present State policy is one of kindly help and conciliation.

FORESTS AND MINES OF VENETIA.

According to a recent consular report, the forests of Bellema, Udine, and Trento are very extensive, and are reasonably supposed to possess almost inexhaustible quantities of timber; but further means of transport are required to bring it into the market. The produce of the pine forests of the mountains of Venetia is sent down in planks, in rafts, along the rivers, to the port of Venice. The commerce in planks is carried on on a very large scale, for the supply of railway companies and for exportation to the East. Venice, on account of its proximity to the Rivers Po and Adijo, is a very important depôt of timber, and there exists, probably, a larger supply of that article than in any port of the Adriatic, or even of the Mediterranean. The mountains are rich in mineral products. In one mine, copper, brimstone, and vitriol are produced; in another, quicksilver and cinabar; and in a third, lead and zinc. There are also iron mines in the mountains, and two argentiferous lead mines—one on the Mount Sovile, and the other in the Val d'Inferno, in the district of Zoldano. Oxide of zinc is also to be found in the same district.

Venice itself, from her geographical position, is the nearest port to Switzerland and to Western Germany, and of equal importance with any other to Eastern Germany; and, as soon as the Government, the province, and the municipality have completed the improvements required, Venice will doubtlessly realise all the advantages of this position. By opening the new port of the Lido, by the institution of the Deposito Franco, by the removal of the rivers from the lagoons, by the reduction of the high duties for imports, particularly on manufactures and colonial produce, and by an equitable modification of the customs' tariff, it is hoped the trade and commerce of Venice will considerably increase.

GERMAN COAL.

The growing development of the trade and consumption of German coal, and the great efforts which have been and continue to be made towards enabling German coal not only to drive its British rival out of the markets of Germany itself, but also to enter into successful competition with the latter as an article of exportation to foreign countries, are facts of so much importance for the interests of all classes at home who are connected with the British coal trade, that Consul Perry devotes a considerable space to this subject in his last report upon the trade of Bremen.

It is doubtless well known, he observes, that the most extensive of the coal fields of Germany are those of Westphalia, and that during the last ten or fifteen years the production of coal, as well as all other branches of industry in that province, have developed themselves in a very striking degree. It is unquestionable that, whilst nearly all other branches of manufacturing industry in Germany have continued to suffer during the last two years under the effects of former excessive production and general commercial depression, the condition of the Westphalian coal industry has become a more and more favourable one. In the course of the year 1875, the general sphere of consumers of coal was greatly extended in Central, West, and North Germany; and Westphalian coal is now in use in many places where formerly either other kinds of fuel, viz., peat, wood, &c., were chiefly employed, or where it was found cheaper and easier to import coal from Great Britain or to a small extent from foreign countries. But by far the most important, however, amongst the districts or towns recently opened up for the consumption of Wesphalian coal, are the two chief commercial cities and seaports of Germany, viz., Bremen and Hamburg. The completion of a nearly straight line of railway connecting these cities with the coal fields of Westphalia, the reduction of the rates of carriage for coal on this line, and other steps taken by the leading merchants of Bremen and Hamburg, in conjunction with the coal-pit proprietors and the railway companies interested in the subject, have already had the effect that British coal is gradually disappearing from use in many households, and by one industrial establishment after the other in these cities and the surrounding districts, whilst the large steamers trading between the Weser and Elbe and Transatlantic countries, as well as the steamers of the German war navy at Wilhelmshaven, which formerly used almost exclusively British coal, have now taken to use the Westphalian article.

The important question regarding the comparative superiority of British and German coal has been settled in a decisive manner (at least from a German point of view) firstly, by a very careful testing of the qualities of the various sorts of Westphalian coal on the part of the Association of Coal Mine Proprietors, at Dortmund, in Westphalia; and secondly, by very minute and thoroughly scientific experiments made by competent persons under the supervision of the German naval authorities at Wilhelmshaven upon about thirty different sorts of Westphalian, and upon about as many varieties of English coal. The results of these investigations show that there are several kinds of Westphalian coal which in all essential points, are at least equal in quality to the best kinds of British coal, and that the former are in every respect as well adapted as the latter for any purpose for which the best kinds of coal may be required.

The results have, of course, been hailed with great satisfaction by all persons in Germany, and more especially by those who are more directly connected with the coal trade. But the interests of the latter have not only been benefited in a very important degree by these investigations undertaken by the German Government, they have been, moreover, materially assisted of late by the fact not only of the large German steamship companies, but also of the German war navy, having almost entirely discarded the use of British coal (excepting, of course, when visiting foreign stations), and having for some months already taken their supplies from the coal pits of Westphalia. Consul Ward believes that these remarks will have rendered it evident that the first steps taken towards removing the difficulty standing in the way of the exportation of German coal have been attended with complete success. It now remains to be seen what results will be attainable by the further measures which may be taken in the same direction by the commercial classes of Germany.

GENERAL NOTES.

The Phonograph.—The New York *Tribune* gives an account of a public exhibition in that city of Edison's Phonograph, which seems to have bsen very successful. The tones reproduced by the vibrating disk of the machine were so distinct that they could he heard and uuderstood in different portions of the crowded room. Words spoken in a high key and with forcible emphasis were reproduced with much greater distinctness than those spoken in a low tone, evsn the latter were uttered very loudly. A difference in the sound of different voices could easily be discerned. Several fragments of songs were sung in a high key and repeated by the machine with wonderful fidelity. The inventor stated that the machine has yet to be perfected before its full power is developed, and that ultimately it can be used to receive and reproduce the songs of popular singers as tbey are rendered on the stage.

Coffee in America.—The Department of Agriculture at Washington has issued a circular relative to the possibilities of the cultivation of coffee in the United States. It appears that the conditions of latitude, climate, and soil of a part of the United States lead to tbe conclusion that the coffse plant or tree can be cultivated to some extent in that country with successful results. The total importation of coffee into the United States in 1876 amounted to 339,789,246 lbs., and cost 56,788,997 dols. It has been established by the best authorities on the subject that great warmth of climate is not absolutely essential to the growth of the coffee plant, but a climate characterised by neither extreme heat or cold and possessing a fair amount of humidity. The climate and soil of Florida, there is every reason to believe, would answer these conditions. So it is also with Lower California and a portion of Texas. This bslief is rendered almost a certainty by the authentic statements that in these regions, at least in Florida and California, there is found growing in abundance a wild coffee plant with many of the characteristics of the cultivated plant. In California the experiment has been tried of planting the berry of coffee obtained from Costa Rica, and the results are reported as satisfactory. The Department of Agriculture proposes to investigate further the conditions of soil and climate essential to the growth of the coffee plant, and invites information or suggestions on the subject. The coffee of commerce comes chiefly from Brazil, Venezuela, Hayti, the British and Dutch East Indies, the West Indies, and Mexico. The plant growing in these countries (*Caffea arabica*) is a tree from eight to twelve feet in height, sometimes attaining a height of twenty and thirty feet. When cultivated, its upward growth is checked by topping for convenience of gathering the fruit. The plants are grown from seed in nurseries, and when a year old are set out. They are in full bearing the third year, and continue so for twenty years, or longer if properly attended to. The plant is an evergreen. While it is cultivated in the tropics, it is a native of the mountainous regions of Abyssinia, from whence it was introduced into Arabia, which for a long time supplied all the coffee then used. Some time in the seventeenth century it was introduced into Batavia and Surinam, and thence into the Western Hemisphere.

NOTICES.

THE LIBRARY.

The following works have been presented to the Library :—

Infant Mortality in Macclesfield. Report of a Special Committee. Presented by Dr. George Bland.

Incidents in the Life aad Times of the Rev. John Wesley, M.A., by J. B. Leslie. Presented by the author.

The Peacemaker, by Thomas Briggs. Presented by the author.

Floods in the Thames Valley, and the Relief of London-bridge and its Approaches, by F. A. Palmer, R.N., A.I.C.E.

Sewer Gas and its Effects, extracts from the works of the leading sanitary authorities.

Remarks on the Sewage Question and F. Hillé's System for the Disposal of Sewage.

Sewage Disinfecting and Filtration Process. F. Hillé's System.

Wholesome Houses. Banner's Patent Sanitary Appliances and System of Sanitation.

A Practical Test of the Excellence of Frozen Meat. Presented by Trübner and Co.

On the Cultivation of the Imagination; an address delivered in the Liverpool Institute on the 24th November, 1877, by the Right Hon. G. J. Goschen, M.P. Presented by J. T. Dawson.

The following have been purchased for the Library :—

Hand-book of Household Science, by Edward L. Youmans, M.D.

Palmer's Index to the *Times*, July 1st to September 30th, 1877.

Simple Lessons for Home Use, chiefly intended for Elementary Schools.

Domestic Economy and Household Science, for Home Education and for School Mistresses and Pupil Teachers, by R. J. Mann, M.D.

Domestic Economy; Thrift in Everyday Life, taught in dialogues, suitable for children of all ages, by G. C. T. Bartley.

The *Times* Register of Events in 1877.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at eight o'clock. The following arrangements have been made :—

February 20.—"The Steam Tramways of Paris," by J. L. Haddan, Esq., M.I.C.E. Col. Beaumont, R.E., will preside.

February 27.—"The Past, the Present, and the Future of the River Thames." By J. B. Redman, Esq.

March 6.—"An Electric Lamp-lighting System." By St. George Lane Fox, Esq.

March 13.—"The Type-writer." By R. Brudenell Carter, Esq., Member of the Council of the Society.

March 20.—"Emery and Corundum Wheels for Grinding and Surfacing Metals and other Materials." By A. H. Bateman, Esq., F.C.S.

March 27.—"Musical Education at Home and Abroad." By Alan S. Cole, Esq.

April 3.—"Our Wealth in Relation to the Imports and Exports of the Country," by E. Seyd, Esq. W. Hawes, Esq., F.G.S., will preside.

African Section.

Tuesday evenings, at eight o'clock. The following arrangements have been made:—

February 19.—"Egyptian Obelisks and their Relation to Chronology and Art." By Basil H. Cooper, Esq., B.A. Admiral Sir Erasmus Ommanney, C.B., F.R.S., will preside.

Indian Section.

Friday evenings at eight o'clock. The following arrangements have been made:—

February 22.—"Irrigation Regarded as a Preventive of Indian Famine." By W. T. Thornton, Esq., C.B.

March 15.—"The Colonisation of Hill Districts in India." By Lieut.-General McMurdo, C.B. Edwin Chadwick, Esq., C.B., will preside.

March 29.—"The Depreciation of the Value of Silver, with Especial Reference to the Exchange between India and England, and Suggestions for a Remedy." By Col. J. Smith, R.E., late Superintendent of Madras Mint.

Chemical Section.

Thursday evenings at eight o'clock. The following arrangements have been made:—

February 28.—"The Chemistry of Infection, or the Germ Theory of Disease from a Chemical point of View." By C. T. Kingzett, Esq., F.C.S.

Cantor Lectures.

Monday Evenings, at Eight o'clock. Second Course, on "The Application of Photography to the Production of Printing Surfaces and Pictures in Pigment." By Thomas Bolas, Esq., F.C.S.

Lecture I.—February 18th.

Photo-lithography and photo-zincography.

Lecture II.—February 25th.

Phototypic, or raised printing blocks, by swelled gelatine process, zinc etching, and other methods.

Lecture III.—March 4th.

Line engraving on metal plates.

Lecture IV.—March 11th.

Printing of half-tone subjects from metal. Application of Asser's process. Talbot's Photo-engraving. Woodbury's methods for engraving and printing.

Lecture V.—March 18th.

Collotypic printing.

Lecture VI.—March 25th.

Other methods of producing photographs in pigment. Dusting-on method. Autotype printing.

Third Course, on "Some Researches on Putrefactive Changes, and their Results in relation to the Preservation of Animal Substances." By B.W. Richardson, Esq., M.D., F.R.S. April 8, 15; May 6, 13, 20, 27.

MEETINGS FOR THE ENSUING WEEK.

Mon.....**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Thomas Bolas, "The Application of Photography to the Production of Printing Surfaces and Pictures in Pigment." (Lecture I.)
British Architects, 9, Conduit-street, W., 8 p.m. Prof. Barff, "The Prevention of Corrosion in Iron."
Medical, 11, Chandos-street, W., 8.30 p.m.
Asiatic, 22, Albemarle-street, W., 3 p.m.
Victoria Institute, 10, Adelphi-terrace. W.C., 8 p.m. 1. Mr. W. S. Chad Boscawen, "The History, Science, and Social Life of Ancient Assyria." 2. Mr. G. Race, "The Formation of Valleys."
London Institution, Finsbury-circus, E.C., 5 p.m. Prof. H. Maudsley, "Hallucinations of the Senses."

Tues....**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (African Section.) Mr. Basil H. Cooper, "Egyptian Obelisks and their Relation to Chronology and Art."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Garrod, "The Protoplasmic Theory of Life and its Bearing on Physiology." (Lecture V.)
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Discussion on "The Evaporative Power of Locomotive Boilers."
Statistical, Somerset-house-terrace, Strand, W.C., 7¾ p.m. Mr. A. J. Mundella, "What are the Conditions on which the Commercial and Manufacturing Supremacy of Great Britain Depends, and is there any Reason to Think they have been or may be Endangered?"
Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.
Zoological, 11, Hanover-square, W., 8½ p.m. 1. Prof. A. H. Garrod, "Notes on the Anatomy of *Tolypeutes tricinctus*, with Remarks on other *Dasypodidæ*." 2. Mr. J. H. Gurney, "Notes on a Specimen of *Polyborus*, lately living in the Society's Gardens." 3. Mr. D. G. Elliot, "A Study of the *Pteroclidæ*, or Family of the Sand Grouse."

Wed....**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr. J. L. Haddan, "The Steam Tramways of Paris."
East India Association, 20, Great George-street, S.W., 3 p.m. Mr. James Routledge, "The Dangers and Advantages of Parliamentary and Popular (English) Interference in the Government of India."
Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Dr. John W. Tripe, "The Winter Climate of some English Seaside Health Resorts." 2. Capt. W. Watson, "Notes on a Waterspout." 3. Mr. M. Fitzgerald, "Notes on the Occurrence of Globular Lightning and of Waterspouts in Co. Donegal, Ireland."
Geological, Burlington House, W., 8 p.m.
Archæological Association, 32, Sackville-street, W., 8 p.m. 1. Mr H. Syer Cuming, "St. Christopher." 2. Mr. W. de Grey Birch, "The Compton Rolls of Oundle Manor." 3. Mr. C. W. Dymond, "Cumbrian Megaleths."
Society of Public Analysts, Burlington-house, Piccadilly, W., 8 p.m. 1. Mr. A. W. Blyth, "The Fatty Metamorphosis of Caseine in Milk and Cheese." 2. Dr. J. Muter, "An Adulteration of Milk which cannot be detected by the ordinary process of Analysis." 3. Mr. G. W. Wigner, "A Numerical Scale for the Estimation of the Degree of Contamination of Drinking Waters as shown by the results of the Analyses." 4. Mr. Otto Hehner, "Experiments on the Chemical Action of Chlorate of Potash on the System."

Thur....Royal, Burlington House, W., 8½ p.m.
Antiquaries, Burlington House, W., 8½ p.m.
Linnean, Burlington House, W., 8 p.m. 1. Mr. E. Lockwood, "Notes on the Malma Tree (*Bassia Catifolia*)." 2. Mr. J. G. Baker, "Synopsis of the Hypoxidaceæ." 3. Mr. Arthur G. Butler, "The Butterflies in the British Museum, hitherto referred to the genus *Euplœa*." 4. Rev. M. G. Berkeley, "The Fungi of the Arctic Expedition, 1875-76."
Chemical, Burlington House, W., 8 p.m. Mr. J. Y. Buchanan, "Laboratory Experience on board the *Challenger*."
London Institution, Finsbury-circus, E.C., 7 p.m. Prof. H. E. A. Armstrong, "Explosives."
Society for the Encouragement of the Fine Arts, 9, Conduit-street, W., 8 p.m. The Second Conversazione; the Concert by "The Musical Artists' Society."
Royal Institution, Albermarle-street, W., 3 p.m. Prof. Dewar, "The Chemistry of the Organic World." (Lecture V.)
Numismatic, 4, St. Martin's-place, W.C., 7 p.m.

Fri.......**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Indian Section.) Mr. W. T. Thornton, "Irrigation Regarded as a Preventive of Indian Famine."
Royal Institution, Albemarle-street, W., 8 p.m., Weekly Meeting. 9 p.m., Professor Odling, "The New Metal Gallium."
Quekett Microscopical Club, University College, W.C., 8 p.m.
Clinical, 53, Berners-street, W., 8½ p.m.

Sat.......Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.
Royal Institution, Albermarle-street, W., 3 p.m. Mr. Bosworth Smith, "Carthage and the Carthaginians." (Lecture V.)

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,318. Vol. XXVI.

FRIDAY, FEBRUARY 22, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

INSTITUTIONS.

The following Institutions have been received into union since the last announcement:—

High School of Trade and Commerce, Queen's College, Birmingham.

Warwick-road School, Warwick.

CANTOR LECTURES.

The first lecture of the second course, on "The Application of Photography to the Production of Printing Surfaces and Pictures in Pigment," by Thomas Bolas, F.C.S., was delivered on Monday evening last, the 18th inst. These lectures will be published in the *Journal* during the recess.

UNIVERSAL CATALOGUE OF PRINTED BOOKS.

The following are the points on which information will be sought:—

I.—Name and address of the informant, and his experience in cataloguing.

II.—His opinion on printing the catalogue on one side only, to enable it to be cut up and arranged in several ways; by subject, by chronology, by printers' names, &c.; also to be incorporated with existing catalogues.

III.—Informant's knowledge and use of—Panzer's, G. W., "Annales Typographici," Norimbergæ, 1793-1803; Hain, L., "Repertorium Bibliographicum," Stuttgart, 1827-38, and such like works.

IV.—As it is proposed to issue the catalogue in sections, do you approve of dividing the catalogue into periods, say, of fifty years? Or would you propose that the first part should extend to 1600?

V.—Do you agree with Sir James Lacaita that all notes of the cataloguist should be given in Latin, or in the language of the respective countries?

VI.—Has the informant any opinion on the cost necessary to be incurred for obtaining a manuscript copy of each title?

VII.—Can the informant state any facts respecting the number of English books printed before, say, 1600?

VIII.—Do you approve of the size of the proposed page and type?

IX.—Does the informant recommend that tenders shall be invited for the printing, or that printers of renowned accuracy should be chosen?

X.—Does the informant recommend that Societies engaged in promoting special branches of literature should be requested to co-operate in furnishing titles?

XI.—Should communications be opened with the Universities of the United Kingdom inviting their assistance?

CHEMICAL SECTION.

Thursday, February 14th, 1878; Mr. T. Wills, in the chair.

The Chairman stated that he had just received a letter from Dr. Gladstone, who was to have occupied the chair, expressing regret that circumstances unavoidably prevented his being present that evening.

The Paper read was:—

SOME RECENT IMPROVEMENTS IN THE METALLURGY OF NICKEL.

By Alfred H. Allen, F.C.S.

The treatment of certain ores, and metallurgical products, for the extraction of nickel and cobalt, has, for a long time, been conducted chiefly abroad; and the very few English firms who have made the extraction of these metals a speciality, have, with more or less wisdom, done their best to keep their processes secret.

Till within the last few years, the ores worked for nickel and cobalt have always contained both these metals, and one of the problems the metallurgist had to set himself to solve was, how most advantageously to separate these two metals from the other elements present and from each other. In their chemical behaviour, as is well known, nickel and cobalt present the closest resemblance; and, had it not been for the difference in the colour of their salts, it is quite possible that we might even now be confounding them.

In practice, the nickel and cobalt have usually been obtained in a matte, or regulus, containing very variable proportions of nickel, cobalt, copper, bismuth, antimony, arsenic, iron, sulphur, &c. In other cases advantage has been taken of the extraordinary affinity of nickel for arsenic, a fact which enables it to be separated from most other metals, and even to be quantitatively determined, as in Plattner's system of analysis by the blowpipe.

After a certain amount of concentration of the matte or speiss by roasting, it has been usual to dissolve the material in acid, and proceed on the well known lines for the separation of the metals. Thus the copper, arsenic, antimony, &c., have been precipitated by sulphuretted hydrogen, the filtrate treated with an oxidising agent, and the iron thrown down with chalk, or by the cautious addition of lime. On treating the filtered liquid with solution of bleaching powder, the cobalt was precipitated as peroxide, and the nickel was separated from the filtrate by addition of lime. This general plan has been varied by separating the iron and arsenic as ferric arseniate, and so on.

The methods, of which the above is an outline, are still employed with more or less modification, but the whole process of nickel and cobalt extraction threatens to be revolutionised by the discovery of deposits of nickel ore of a very extraordinary character in New Caledonia.

Although in works on mineralogy mention is made of oxidised minerals containing nickel, almost the only nickel minerals practically available, a few years since, were the highly complex sulphides and arsenides already referred to. In many cases the proportion of nickel contained in these ores is very small, ores with three or four per cent. being frequently worked.

The peculiarity of the New Caledonian ore is its

almost absolute freedom from arsenic, copper, and other metals precipitable from acid solutions by sulphuretted hydrogen, with simultaneous freedom from sulphur. It is also remarkable that many specimens are almost wholly free from cobalt, and in no instance have I met with any considerable proportion of that metal.

The ore in question consists essentially of hydrated silicate of nickel and magnesium. Many specimens contain a considerable quantity of iron, which appears to exist partially as ferrous silicate. Most of the cargoes I have examined have contained a very appreciable quantity of chrome-iron ore.

The mineral which is richest in nickel is of a bright green colour, in some cases almost rivalling the lighter shades of malachite. Between this and pure magnesian silicate there is every gradation, and, of course, the composition varies within very wide limits.

The mineral has been met with in other places besides New Caledonia, and has been variously christened. Of course the analyses show great variations, and on that account it is difficult to attribute any satisfactory formula to the mineral. The following details will serve to show the composition of the mineral in its purest form:—

Name.	Locality.	Observer.	Specific Gravity.	SiO_2.	Al_2O_3	Fe_2O_3.	FeO.	NiO.	=Ni.	CaO.	MgO.	H_2O.
1. Genthite	Lancaster Co., Pennsylvania	Genth.	2·41	35·36	..	..	·24	30·64	24·07	..	14·60	19·09
2. Genthite ..	Webster	Dunnington.	2·48	49·89	..	..	·06	22·35	17·56	..	16·60	12·36
3. ..	New Caledonia	Liversidge.	2·27	47·24	..	1·77	..	24·01	18·86	trace.	21·66	5·27
4. ..	ditto.	Typke.	..	55·90	..	·82	..	35·56	27·94	trace.	·81	7·51
5. ..	ditto.	Christofle.	..	37·6	..	6·60	..	18·66	14·66	..	15·00	*21·6
6. Garnierite.	ditto.	Garnier.	..	41·0	..	·60	..	19·0	14·93	trace.	16·3	*20·0
7. ..	ditto.	Allen.	2·86	52·41	none.	none.	·78	30·14	23·68	trace.	10·37	6·27
8. Pimelite ..	Silesia.	Klaproth.	..	35·00	5·00	4·58	..	15·63	12·28	·42	1·25	38·12
9. Alipite....	ditto.	Schmidt.	1·46	54·63	·30	..	1·13	32·66	25·66	·16	5·89	5·23
10. Pimelite ..	ditto.	Baer.	2·71	35·80	23·04	2·69	..	2·78	2·18	..	14·66	21·03

Taking the silica, oxide of nickel, magnesia, and water, as the essential constituents of the mineral, the following formulæ may be deduced—RO, consisting in each case of NiO and MgO.:—

No. 1. $2RO, 3SiO_2 + 6H_2O$.
No. 2. $RO, SiO_2 + \frac{3}{4}H_2O$.
No. 3. $10RO, 8SiO_2 + 3H_2O$.
No. 4. $RO, 2SiO_2 + H_2O$.
*No. 5. $RO, SiO_2 + 2H_2O$.
*No. 6. $RO, SiO_2 +$ (nearly) $2H_2O$.
No. 7. $4RO, 5SiO_2 + 2H_2O$.
No. 9. $2RO, 3SiO_2 + H_2O$.

The above figures afford abundance of choice to those desirous of establishing any particular formula, and sufficiently indicate the general character of the mineral.

Although silicate of nickel is met with in other places besides New Caledonia, the existence of considerable deposits of rich ore is, however, so far as is known, almost wholly confined to that locality. The same mineral has been found and even mined in Spain, in the province of Malaga, but the ore there found is much poorer than the New Caledonian mineral, as will be seen by the following analyses of the Malaga ore, which I made in 1875:—

Silica	37·48	37·14
Alumina	34·38	28·59
Oxide of iron, (calculated as FeO)	9·00	12·21
Oxide of chromium	3·60	4·37
Oxides of nickel (and cobalt)	3·98	4·00
Magnesia } Lime }	11·76	{ 10·91 { 1·53
Sulphur	traces	·13
	100·20	98·88

*It is very probable that a portion of the water shown in these analyses was merely hygroscopic, and not water of composition.

The ore contained no copper or other metal precipitable by sulphuretted hydrogen in solutions containing free mineral acids, with the exception of traces of lead and arsenic. It will be observed that in this case there is no combined water. Whether the mineral had undergone any treatment before it came into my hands I am unable to say. Ore from the same locality has been described by M. Meissoniere as Pimelite, and found to contain 9·0 per cent. of nickel.

Of course, the ore actually obtained from New Caledonian mines is not always as rich as the specimens the analyses of which are quoted in the above table; in fact, it has been found difficult to insure cargoes of ore attaining the contract quality of 10 per cent. metallic nickel on the ore dried at 100° C. In an instance known to me, a cargo of ore was imported to England on the strength of an analysis showing the sample to contain 29 per cent. of metallic nickel, and only 3 per cent. of magnesia, whilst on arrival the bulk only assayed 12·3 per cent. of metallic nickel.

A large number of samples of New Caledonian ore have passed through my hands professionally, and I have, therefore, had the opportunity of becoming thoroughly acquainted with its composition.

The following analyses fairly represent the quality of the ore imported to this country. No. 1 contains a larger proportion of moisture than is usual, but the ores are remarkably hygroscopic, gaining 3 or 4 per cent. on exposure to a fairly dry atmosphere for a few hours.

	No. 1.	No. 2.
Silica	46·44	40·45
Alumina	·06	1·54
†Oxide of iron	1·83	4·96

† Calculated as FeO.

	No. 1.	No. 2.
Oxide of copper	none	·03
Oxide of lead	none	·09
Oxide of nickel	15·33*	13·25†
Magnesia	15·90	24·62
Lime	traces	traces
Combined water	8·02	9·40
Moisture	11·30	5·60
	98·88	99·94

Although the analysis of such ores as the above is much simplified by the absence of many of the metals commonly associated with nickel, a really rapid and accurate method of assaying New Caledonian ore is still a desideratum. I have, however, used a process of which the following is an outline, with considerable facility, and can recommend it as being thoroughly reliable and well suited for its intended purpose. Two grammes of the dried sample are fused in platinum with acid sulphate of potassium and a fragment of nitre. When decomposed, the contents of the crucible are treated with hot water, the residue boiled with hydrochloric acid, and then the whole filtered. The solution is nearly neutralised by cautious addition of ammonia, is next treated with ammonium acetate in excess, boiled well, the iron, aluminium, and chromium filtered off, and the precipitate redissolved in hydrochloric acid and again precipitated with acetate. The mixed filtrates and washings are heated to boiling, ammonia added till but little free acetic acid remains, and then a current of sulphuretted hydrogen gas is passed, the solution being kept constantly boiling.

In this manner the nickel (and cobalt) are completely thrown down as sulphides, and thus the difficult separation from magnesia is readily effected. The precipitate is washed with water containing ammonium acetate and sulphuretted hydrogen, and is then rinsed off the filter and treated with nitric and a few drops of sulphuric acid. When completely dissolved to sulphate, ammonia is added in large excess, and any small precipitate filtered off. The ammoniacal solution can be treated in two ways. It may be introduced into a platinum crucible, and the nickel thrown down on the platinum by the current from two cells of Grove's battery, a platinum plate being immersed in the liquid as an anode. The only precaution necessary is to keep the solution strongly ammoniacal, and allow plenty of time for the precipitation. The results are very accurate, with a tendency to be below the truth. Of late, I have abandoned the electrolytic method for direct weighing of the nickel as sulphate. The solution of double sulphate of nickel and ammonium is evaporated to dryness, and the residue heated to dull redness. It is moistened with a drop of nitric and the same of sulphuric acid, and again gently ignited. The result is pure anhydrous sulphate of nickel, containing any cobalt (or copper) which might have been present in the original ore.

I am indebted to the kindness of several of my clients for the specimens of New Caledonian and other nickel ores arranged for your inspection. The following mineralogical description applies to the purer specimens of New Caledonian ore.

The mineral is amorphous and generally much fissured. The fissures are often filled in with white silica, which thus forms thin plates, crossing one another in every direction, and enclosing the green mineral between them.

In colour the mineral is of a bright apple-green. On immersion in water, some specimens fall to pieces with a crackling sound, the fragments having a conchoidal fracture.

The hardness is about $2\frac{1}{2}$, and the specific gravity from 2·2 to 2·9. The streak is pale green. The mineral gives off water when heated. Fused in a borax bead on platinum wire, it gives the ordinary nickel bead.

The mineral usually occurs in veins traversing serpentine rock, and is associated with chrome-iron, steatite, and other minerals commonly occurring in serpentine. It also occurs as a green coating on the rocks. Veins are said to exist in which the nickel is wholly replaced by cobalt.

It is evident that a tolerably abundant mineral, containing no appreciable quantity of any foreign heavy metal but iron, is eminently adapted for the extraction of nickel, and consequently it has attracted considerable attention, and the economical extraction of nickel from it has been made the subject of at least half-a-dozen patents.

One of the chief of these is the patent of MM. Christofle and Bouilhet, of Paris. This is a wet process based on the solution of the ore in hydrochloric acid, oxidation of the iron by chloride of lime, precipitation of the iron by chalk, and cautious treatment of the filtrate with lime water, so as to precipitate the oxide of nickel and leave the magnesia in solution. In practice, however, the inventors find it preferable to use chloride of lime, employing lime water merely for the conclusion of the precipitation. It is found impossible to prevent co-precipitation of the magnesia, so the patentees make a virtue of necessity, and boldly claim as part of their invention "the precipitation of a small quantity of magnesia in conjunction and in combination with the last traces of nickel, so that, in the presence of carbon and of sulphates contained in the oxide of nickel, a sulphurous scoria shall be formed during and in the reduction of the nickel."

I am myself the inventor of a method of extracting nickel from the New Caledonian ore, which method I believe to be based on sound principles, and that under somewhat altered circumstances it might be found of considerable value. These considerations must be my apology for laying it before you.

Being in the habit of frequently assaying samples of New Caledonian ore, I was struck with the facility with which it was decomposed by acids. For several reasons I had usually employed sulphuric acid for the decomposition, and the advantage of using this reagent instead of hydrochloric acid was thus very apparent. When hydrochloric acid is employed, a considerable excess of the reagent must be used, and the product is a highly acid liquid or jelly. The effect of sulphuric acid on New Caledonian ore is very remarkable. Thus, if I treat a known weight of the powdered ore with a quantity of sulphuric acid and water corresponding to an equal weight of brown vitriol, the action speedily begins (without application of external heat), the mixture swells up and quickly sets to a bulky, dry, porous mass, consisting of fine silica mixed with sulphates of nickel, iron, and magnesium. The action strongly reminds one of that by which "superphos-

* Equal 12·05 per cent. Ni. † Equal 10·42 per cent. Ni.

phate" is manufactured. It is well to add a small proportion of nitrate of soda, so as to avoid the necessity of peroxidising the iron at a subsequent stage of the process.

It is next desirable to heat to redness so as to get rid of the free sulphuric acid. The product is a dry white powder.

The ignited product is next dissolved in a minimum quantity of water, by which means silica, chrome-iron, and any undecomposed ore are left as a residue, and the metallic sulphates are obtained in strong solution. The residue is allowed to settle as completely as possible, and the deep green solution is then syphoned off. As the metals present exist as sulphates, the addition of any compound of calcium is very objectionable, and hence I replace the usual dose of lime or chalk by magnesia obtained by igniting magnesite. The magnesite in the market contains fully 98 per cent. of real magnesium carbonate, and is therefore well adapted for the purpose.

It is desirable to know beforehand the amount of iron present in the liquor, and then to add the theoretical quantity of magnesia necessary for the reaction:

$$Fe_2 (SO_4)_3 + 3MgO = Fe_2O_3 + 3MgSO_4.$$

I have found in practice that, if introduced in the form of fine powder, the ignited magnesite will do almost the calculated amount of work. It is desirable, however, to test the liquid towards the end of the precipitation, and to add a little more magnesia if necessary. Any excess will cause precipitation and consequent loss of nickel. I have proved experimentally that no nickel is precipitated as long as any ferric salt remains in solution. With the oxide of iron is precipitated any alumina or oxide of chromium which may be present, and the precipitate also carries down with it any silica or other suspended matters. The next step is to precipitate the nickel while leaving the magnesium in solution. This can be effected by several methods, of which the following are to be preferred.

Addition of an amount of calcined magnesite exactly sufficient to precipitate the nickel, with simultaneous or subsequent treatment with sulphuretted hydrogen; the process being conducted at a boiling heat. The following is the reaction :—

$$NiSO_4 + MgO + H_2S = NiS + MgSO_4 + H_2O.$$

This reaction is not only perfect theoretically, but experiment has shown that precipitation of the nickel is complete without addition of any magnesia beyond the amount theoretically necessary. The method suggested itself after many unsuccessful attempts to prepare a sulphide of magnesium. The sulphide of nickel is obtained as a dense black precipitate not readily oxidisable. It may be converted into oxide of nickel and metallic nickel by the usual processes. An experiment on half a hundredweight of New Caledonian ore showed that the above process was thoroughly practicable.

The objection to the above mode of precipitating the nickel is that it is obtained as sulphide, and thus requires further manipulation to fit it for reduction to metal. A glance at the above equation appears to indicate that, if the sulphuretted hydrogen were omitted, the nickel would be obtained directly in the convenient form of oxide, according to the equation—

$$NiSO_4 + MgO = NiO + MgSO_4.$$

Such, however, is not the case. The reaction which is so perfect with the aid of sulphuretted hydrogen is incomplete in its absence. Owing, probably, to the affinity of magnesia for oxide of nickel, it is impossible completely to decompose a solution of nickel sulphate, even when the magnesia is added in considerable excess, and in the form of recently precipitated hydrate. This statement requres some modification, however, for by operating in a particular manner, I have found it possible wholly to separate the nickel from a solution containing nickel and magnesium sulphates merely by the treatment with magnesia, and in such a manner as to leave the liquid free from nickel, while the precipitate contains no magnesium. In this manner pure oxide of nickel may be extracted from the New Caledonian ore without employing any reagents besides sulphuric acid and calcined magnesite (and an insignificant quantity of nitrate of soda). This modification of the process has not hitherto been tested on larger quantities than 1 lb. of ore.

When New Caledonian ore is treated by magnesia for the separation of the iron and the nickel, the liquid separated from the precipitate containing the latter metal is a concentrated solution of nearly pure magnesium sulphate. An essential part of the invention for which I claimed protection was the production of magnesium sulphate from these liquors by the process of evaporation and crystallisation. Average samples of ore would yield nearly 150 per cent. of crystallised "Epsoms," and I found that by far the greater part of this amount was fairly obtainable. If undue dilution of the liquors be avoided, the fluid separated from the nickel precipitate is nearly saturated with magnesium sulphate when cold. Nor has this been obtained wholly from the magnesite used, for, if the ore contatn 15 per cent. of magnesia, the yield from that source alone is theoretically equal to $92\frac{1}{4}$ per cent. of crystallised sulphate. But it is just this abundant production of "Epsom salts" that prevents the process being a complete success. Any magnesia in the ore necessitates the employment of sulphuric acid for its saturation. It would require very exceptional circumstances to enable the above enormous yield of "Epsoms" to be useful as a purgative, but really the chief application of magnesium sulphate is for weighting cotton-cloth.

A few years ago the manufacture of "Epsoms" in the above manner would probably have been a perfect success; but the discovery of the native deposit of magnesium sulphate, known as kieserite, prevents any likelihood of its profitable manufacture from nickel ore, while the present price of nickel is insufficient to admit of the process being successfully worked without regard to secondary products. As mentioned before, however, the process is sound in principle and may become available under altered circumstances.

A process somewhat akin to my own has been patented by M. Kamienski, of Paris. In point of date, his patent has somewhat the priority of mine, my specification having been filed before the lapse of the six months which ended with the publication of his patent.

M. Kamienski dissolves in hydrochloric acid, separates silica, precipitates the iron with chlorine water and carbonate of magnesium, and then

separates the nickel from the magnesium, by fractional precipitations with carbonate of sodium. He obtains common salt as a secondary product. It is evident that the same objections which render my process imperfect, apply with much greater force to that of M. Kamienski.

As the New Caledonian ore contains only some 15 per cent. of heavy metals, it is evident that very great and desirable concentration would be effected by a furnace operation which would get rid of the silica and magnesia. Various processes have been suggested, in which this principle is applied, the following being those most worthy of notice.

M. Jules Garnier has patented a process by which he proposes to obtain an impure cast nickel by melting the New Caledonian ore in crucibles with carbon and appropriate fluxes. He also proposes to smelt the ore in a blast furnace similar to that used for the production of pig-iron, tapping off the molten metal at intervals, &c., and subsequently refining the crude nickel by puddling or treatment in a Bessemer converter. Whenever M. Garnier succeeds in working these processes to a profit, German silver will drive brass quite out of market, and, doubtless, many of our common iron implements will be superseded by those manufactured of nickel. Following the precedent M. Garnier has already set, in calling the New Caledonian ore "Garnierite," he might christen the metal resulting from the above patented processes the name "Garnierium" or "Garnier-nickel."

The next dry process for treating New Caledonian ore is that of Mr. Alexander Parkes, of Birmingham. As described in his patent, the process consists in fusing oxidised compounds of nickel with oxide of copper, fluxes, and carbonaceous matter, so as to obtain an alloy of copper, nickel, and iron, which is to be subsequently refined. A suitable mixture consists of one ton of ten per cent. ore, four hundredweights of fluor-spar, half a hundredweight of rock salt, four hundredweights of copper scales, and two and a half hundredweights of anthracite; these are well mixed and subjected to a good heat in a reverberatory furnace for four or five hours, when an addition of from two to four hundredweight of granulated metallic copper is made, and after another hour the charge is tapped into moulds, or skimmed and run into water. To refine the crude metal thus obtained, one ton is remelted with two or three hundredweight of copper scales, one hundredweight of sand, and a half hundredweight of lime, an oxidising atmosphere being maintained.

This process has been very perseveringly tried, on a manufacturing scale, under the immediate superintendence of the inventor. As in most of the applications of nickel the metal is used in alloy with copper, the above method seems admirably adapted for the purpose. The first product contains more or less iron, and in practice it has been found very difficult to refine this even by repeated treatments with copper oxide. The alloy thus contains an excessive proportion of copper, and German silver prepared with it, requires a further addition of unalloyed nickel obtained by some other process. This is a great disadvantage, but the product would, nevertheless, have made its way had the German silver produced by it been of good quality. The cause of its failure in this respect is not very apparent. I have examined various samples of the copper-nickel alloy resulting from the treatment of New Caledonian ore by Parkes' process, and their analysis have by no means indicated the origin of the difficulty. The following analyses represents the general composition of the alloy, a specimen of which is on the table:—

	A. Per cent.	B. Per cent.	C. Per cent.
Arsenic	none	trace	none
Copper	74·80	68·31	65·80
Lead	trace	——	trace
Iron	·87	1·47	trace
Nickel	23·60	29·08	33·50
Sulphur	·45	·25	·34
	99·72	99·11	99·64

I am far from believing it impossible to overcome the difficulty connected with the use of Parkes' alloy, but I am unable, without committing a breach of confidence, to indicate the direction in which I am disposed to look for success.

An alternative process, described under Parkes's patent, consists in fusing New Caledonian ore with fluor-spar and carbon, with addition either of sulphur, sulphate of barium, or sulphate of calcium. By this means the patentee claims to obtain a sulphide of iron and nickel which he can treat for the preparation of nickel by well-known processes. I have had some experience with the product of this mode of treatment, and find the results very different from what the patentee supposes. By fusing New Caledonian nickel ore with fluor-spar, salt, sulphur, and carbon, there is obtained not a sulphide, but a silicide of nickel and iron. A regulus obtained in this way contained 17 per cent. of silicon, of which ·2 per cent. was graphitoïdal, and the rest combined. It might be supposed that the failure to obtain a sulphide was due to the volatilisation of the free sulphur at a comparatively low temperature, but a similar product (though poorer in silicon) resulted when I substituted a mixture of plaster of paris and coke for the free sulphur of the previous experiment. By somewhat varying the conditions, I found it quite possible to obtain a sulphide free from silicon. I am engaged in experimenting on the whole subject, and propose to employ the process for obtaining pure silicide of nickel, and to see how far the method is generally available for the preparation of metallic silicides. It is evidently more convenient than those involving the use of potassium silico-fluoride, and it will probably much facilitate the preparation of graphitoïd silicon.

Before leaving the subject of Parkes's patent, I may say that recent experiments made at Birmingham, on a manufacturing scale, have given exceedingly hopeful results, but success is not yet completely attained.

By whatever method the ore is treated, the ultimate product (except in the case of Parkes' copper-nickel) is a more or less pure oxide of nickel. This is reduced by heating in pots with charcoal. The curious masses of metallic nickel known as cube nickel are made by mixing the oxide with wheat-flour and water, so as to form a thick paste, which is cut into cubes with a knife and dried. In some cases the flour is omitted, the precipitated oxide being itself cut into cubes. The cubical masses are heated in a plumbago crucible, with charcoal powder.

Commercial nickel varies much in quality. Some samples are mere alloys of copper and nickel. All the so-called "nickel coins" are really copper-nickel alloys, containing a large proportion of copper, generally two-thirds of the whole weight. Copper is in no way objectionable in nickel to be used for the manufacture of German-silver, but the presence of more than traces of iron, sulphur, lead, and antimony must be carefully avoided.

In analysing samples of commercial nickel and nickel alloys, it is well to remember that the deservedly favourite method of precipitating copper with the thio-sulphate (hyposulphite) of sodium cannot be employed, as very considerable quantities of nickel are liable to be simultaneously precipitated. Results obtained by this process are sometimes erroneous to the extent of five per cent. or even more. As nickel alloys are valued by the units of nickel contained, and nickel is worth 5s. per lb., this difference is quite intolerable. A process I have largely employed with exceedingly satisfactory results is the precipitation of copper as cuprous sulphocyanide, by adding an alkaline sulphite and sulphocyanide to the faintly acid solution of the alloy. Another good method is electrolysis in an acid solution of the sulphates. After removing the copper, the nickel may be thrown down in the same manner in the solution rendered strongly ammoniacal.

The following are analyses of nickel obtained by Christofle from New Caledonian ore. No. 1 was melted nickel obtained by a wet process. No. 2 was manufactured by a combined wet and dry method:—

	No. 1. Per cent.	No. 2. Per cent.
Carbon	1·25	——
Silicon	·54	·13
Copper	——	·50
Manganese	·36	——
Iron	——	1·60
Nickel	97·75	98·00
	99·90	100·23

As in case of iron, the presence of carbon or silicon greatly promotes the fusibility of nickel. Pure nickel is well known to require a very high temperature for its fusion, and when this difficulty is overcome, it is difficult to obtain the casting free of bubbles. Professor Winkler has recently achieved great success in this direction, and has obtained large and compact ingots of pure nickel and cobalt by ensuring a sufficiently high temperature, suitable pots, taking precautions to keep out carbon and silicon, and casting in an atmosphere free from oxygen. For the fusion he employs a porcelain crucible embedded in a magnesia packing contained in a Hessian clay crucible, which last is inserted in a graphite crucible and imbedded in fire-clay. To obtain castings free from bubbles, it is found necessary to pour the metal into the mould through a flame of burning petroleum.

The casting of the nickel plates to serve as anodes for the electro-nickeling cells has recently become necessary. The melting is effected in ordinary steel pots with the addition of a little borax or other flux.

The following analyses of a nickel anode is due to Mr. W. E. Gard. They are interesting as showing the effect of the electro-chemical action. A. is the original anode, and B. the same anode after the loss of upwards of 50 per cent. of its weight by solution in the electro-nickeling vat:—

	A. Per cent.	B. Per cent.
Carbon	1·10	1·90
Silicon	·13	·26
Sulphur	·30	·10
Iron	·11	·31
Cobalt	trace	trace
Nickel	98·36	97·43
	100·00	100·00

A very useful addition to nickel to be cast into plates for anodes is a small proportion of tin. It adds considerably to the fusibility of the metal without causing any subsequent inconvenience.

The process of depositing nickel by the battery is one which is now very extensively carried on, and has been the subject of more than one lawsuit.

Practically, the only solution employed for the electro-deposition of nickel is that of the double sulphate of nickel and ammonium. It seems important to avoid the presence of fixed alkalies, and nitrates are also said to be prejudicial. In the patent granted to Brookes, elaborate precautions are taken to ensure the production of a pure nickel salt, and the company interested in working this process appear to have been disagreeably astonished to find that such precautions were unnecessary.

Besides patents for the deposition of nickel from solutions containing the cyanide of nickel and potassium, the tartrate of nickel and potassium, and the chloride of nickel and ammonium, several patents have been taken out for the use of the double sulphate of nickel and ammonium. In the course of an inquiry into the details of one of those processes, I observed a very curious fact, which I subsequently incorporated in a specification drawn up for the use of my clients, and which I see has formed the foundation of a recent patent described as the invention of a Mr. John Unwin. Mr. Unwin was at the time acquainted with my experiments, and for a time had the specification in his possession, which latter fact may perhaps account for the very similar wording of his patent.

Although the double sulphate of nickel and ammonium $(NiSO_4 + (NH_4)_2SO_4 + 6H_2O)$ is readily soluble in water, even more so than the sulphate of nickel itself, it is almost insoluble in liquids containing much sulphate of ammonium. Hence, if a strong solution of ammonium sulphate be added to a liquid containing sulphate of nickel or sulphate of nickel and ammonium, a beautiful light blue crystalline precipitate of the double sulphate is thrown down, and the liquid becomes nearly colourless. So complete is the precipitation, that the method may be used to precipitate the nickel in old vat liquors.

Excess of sulphate of ammonium causes a similar precipitation in a solution containing sulphate of magnesium or ferrous sulphate, but not in a solution of ferric sulphate. The ferrous and magnesium sulphates are not precipitated with nearly the same ease as the nickel sulphate, but in presence of the last salt, they are more or less dragged down with the nickel precipitate.

As iron in the ferric state is not precipitated, the impure solution of nickel sulphate obtained by the solution of metallic nickel in a mixture of nitric and sulphuric acids, can readily be treated with

excess of ammonium sulphate, and the precipitated double sulphate of nickel and ammonium separated, washed with water containing sulphate of ammonium, and redissolved to prepare the nickel-plating bath.

The solution for depositing nickel should not have a higher density than about 1030, and should be kept rather alkaline than acid. The current must be carefully regulated, or the deposit loses its lustre. A coating of any thickness may be deposited, and almost any metal may be covered. The deposit of nickel is especially suited for iron and steel articles. A number of specimens of nickel-plated articles are on the table. I am indebted to the Sheffield Nickel-plating Company for the loan of them. The deposit is but little liable to tarnish in a fairly dry atmosphere, but it is unable to withstand the influence of continued damp. For fire-irons, polished fenders, and other comparatively large articles of steel and iron, it is very well suited; and for coating surgical instruments, and similar articles of steel, its use is daily extending.

It has been proposed to employ a magneto-electric machine for separating metallic nickel from the crude solution of the ore, but I am not aware that the process has been actually carried into effect.

The discovery of the New Caledonian deposits will, no doubt, before long cause a great extension in the application of nickel and its alloys, while, at the same time, from the neglect of the old ores and processes, cobalt compounds will become more expensive.

DISCUSSION.

Mr. Riley—I should just like to ask Mr. Allen, with reference to his process for estimating nickel, whether he has ignited the sulphide directly in a muffle. That gives excellent results. I have most carefully checked the process, and I have found that the best method is simply to take the sulphide, and to unite it in a muffle, and weigh it afterwards as oxide. By this means you get rid entirely of the sulphuric acid. It is not sufficient merely to heat it over a gas flame. I have made several careful experiments upon that point, and I was perfectly satisfied as to its accuracy. It considerably reduces the labour of the analysis. In fact, I must say that the analysis of these Caledonian ores is by no means difficult. I am sorry that I did not catch very clearly the mixture used in making the silicide of nickel. I should like to know the conditions under which it was formed, because taking analogous metallurgical operations, one would imagine that there must have been an excessively high temperature, for a high temperature and an excess of carbon in the presence of silicon would tend to produce a silicide. I am speaking without having before me the details of the mixture that was used, and I should hardly like to venture on any statement as to what action the sulphur might have. With regard to cube nickel, I do not think it is at all necessary to mix it with starch. It is sufficient simply to cut the cubes of oxide and bed them in charcoal. I saw that done at Liege some years ago, and the reduction is complete and satisfactory. As a fact, discoverable by analysing the samples, the cube nickel is not so pure as the grain nickel. I may say that, if you have a high temperature, there is no difficulty in getting an alloy of silicon and iron containing 23 per cent. of silicon. I think Mr. Allen said 17 per cent. was found in this case. I quite agree with the statement as to the absorption by these ores of a very large amount of water. The amount is extraordinary; but I do not think that it is at all peculiar to metal ores. I have found the same in silicates of magnesia, just the same as in metal ores. I think it is simply a property due to the silicate of magnesia.

The Chairman—I should like to ask Mr. Allen if he could give us any information as to the probable extent of the deposit of the mineral that is to be found in New Caledonia; and also whether the carbon, which occurs in the finished nickel to the extent of from 1 to 1·5 per cent., has any effect upon the hardness of the material in the same way that the carbon present in iron has. Also, I should like to know whether there are no traces of phosphorus to be found in the mineral. There are none at all represented here in these tables. It would seem likely that there would be traces of phosphorus found in the mineral.

Mr. Allen—With respect to what Mr. Riley has said about the sulphide of nickel, I have tried it, but I cannot say that I have had any experience of the process. The difficulty is that sometimes the sulphide is not pure as precipitated, but contains traces of foreign metals, and therefore I have always preferred to purify it. If I could know for a certainty that the sulphide was pure, I can understand that the process would answer very well.

Mr. Riley—We always test it after drying.

Mr. Allen—Just so. You propose, of course, to do it with a closed crucible in the same way as you do copper. The sulphide of nickel you propose to ignite in a closed crucible. I find that the sulphate of nickel requires a very full red heat to decompose it.

Mr. Riley—I prefer to wash the sulphide in a muffle' and ignite it until it ceases to lose weight.

Mr. Allen—Then, respecting the silicide, I do not say that there is anything extraordinary in getting 17 per cent. of silicon in it; but the curious point was this—that the patentee gives that process for obtaining the sulphide, and the samples that came into my hands consisted of silicide with only a trace of sulphide. And another curious point is that it was done by heating with sulphur in one case, and by heating with sulphate of calcium in another. It was rather remarkable that in those cases there should be no sulphide. There are other patent processes, notably a patent known as Holway's, in which a silicide of manganese is obtained. Silicides of manganese are well known, and have been obtained very rich in silicon, and, speaking generally, the characters of the silicides of nickel seem to agree with those of the silicides of manganese. It is also interesting with regard to the graphitoidal silicon. Mr. Riley rather anticipates me by asking specific information on the subject, when I say that I propose to investigate it further. I am not aware that it has been obtained or investigated before; but Mr. Riley will have an opportunity of criticising when I communicate results.

Mr. Riley—I may, perhaps, remark, if it is not quite out of place, that silicon does drive out sulphur. You will not find sulphur where you have much silicon. The silicon will drive out the sulphur. I do not know whether the high temperature may not account for it.

Mr. Allen—The curious point, to my mind, is, that when the invention was introduced to get the sulphide, the inventor should succeed in getting the silicide. I may say that this silicide only oxidises superficially at a red heat. You can roast it in the form of a coarse powder. All the outside fragments will oxidise and the rest remain unchanged, and it is very difficult to dissolve it in acid. It takes hours to dissolve it in *aqua regia*. A mixture of hydrofluoric and nitric acids dissolves it most readily and completely. As to the cube nickel, of course

the cube nickel is obtained sometimes in that way, and when the process has been made continuous, cubes of metallic nickel having been drawn out at the bottom, while the top of the apparatus has been fed with the oxide of nickel. With regard to what Mr. Wills said about the carbon hardening the metal, I have no doubt for a moment that the carbon does harden it after the fashion of iron; but I have no particular experience in that direction, and I am not able to tell anything of my own experience. Then as to the quantity of ore. I do not know the extent of the resources in New Caledonia, but a great deal comes over. There are many hundreds of tons in England, at any rate, so that we may suppose that there is a considerable supply. The importers profess to be somewhat doubtful as to the extent to which the veins exist. It is uncertain how far they do extend; but if they do last, I think we may agree that it is likely to exert a very considerable influence on the metallurgy of nickel and the mode of producing it. The whole question is a new one. I have been, to a certain extent, interested in it for some time, and I thought that it might be of interest to bring these matters forward. With regard to the presence of phosphorus in the ore, I may say we always test for phosphoric acid, but have not found it.

The Chairman—There is no question that the discovery of a new source of such a valuable material as nickel is a very great gain, and especially such a pure ore as we have in this case. Apparently, the mineral which Mr. Allen has called our attention to from New Caledonia, contains almost the largest percentage of nickel of any metal ore. It also seems to be singularly free from those metals which are usually associated with nickel ores—copper and cobalt. In view of the general use of nickel, I fancy that it is of considerable importance to know the extent of this mineral. It is quite possible, for a time, to get over large quantities of this substance, but afterwards it may be found that the veins from which it is obtained are not of any large extent; and, therefore, it will be of some consequence to know at once what quantity may be expected from that part of the world. There can be very little doubt that if a good and regular supply of nickel could be obtained it would come into very much larger use than it has yet done. It is singularly well suited for electro-plating, as Mr. Allen has pointed out. For the plating of iron and steel articles, it is likely to have a very extended application; so, also, for the larger manufacture of German silver. The restricted use of nickel for these purposes has, I believe, been largely due to the difficulty of getting it in sufficient quantity, and of getting a process for its extraction, which is at once paying and easy of being carried on. The processes which Mr. Allen has brought before us evidently point, with this new material, to a better state of things with respect to the metallurgy of this metal, so that the nickel may come into the market; in which case, nickel-plated goods will be seen and used very much more largely in future than they have been in the past. I have to ask you to return your thanks to Mr. Allen for his interesting paper, and for the trouble he has taken in bringing it before the Society this evening.

The thanks of the meeting having been given to Mr. Allen for his communication, the proceedings closed.

AFRICAN SECTION.

Tuesday, February 19th; Admiral Sir Erasmus Ommanney, C.B., F.R.S., in the chair.

The Chairman, in opening the meeting, said—In consideration of the deep interest which we must all feel on the occasion of the safe arrival of the Egyptian obelisk, commonly styled Cleopatra's Needle, within the area of this metropolis, the Council of this Society deem it fitting to celebrate this event by affording the members an opportunity of receiving a description of these remarkable historical monuments of ancient days. This obelisk, now lying enclosed within an iron cylinder floating on the waters of Father Thames, was quarried 3,400 years ago out of the bed of granite contiguous to the first cataract of the Nile at Assouan, 750 miles south of Cairo; so that to reach this country it has travelled by river and ocean 3,000 miles, and escaped many perils by sea and land. Let us, in this Society of Arts, convey our tribute of gratitude to Professor Erasmus Wilson for his generosity for providing the means of bringing to them this memorable record of antiquity, and to Mr. John Dixon, who has by his skill, ingenuity, and enterprise, provided such a suitable vessel for its transport. What associations may be suggested to anyone looking down from Westminster-bridge on the vessel containing this mysterious monument of a nation which, 40 centuries past, was advanced in a very high standard of art and science, whose gigantic temples and tombs are a lasting marvel to the present day, and whose symbolic language has been a closed letter up to very recent times. This obelisk comes amongst us at a very eventful period, when the destinies of the East may undergo as great a change as when the Assyrian, the Babylonian conquerors, and the great Alexander transformed the state of things in the then civilised portion of the earth; it comes to us at a moment when the Mohammedan power in Europe lies at the mercy of northern conquerors; when the descendants of the Prophet which cast down the idols of the Egyptians, and stamped out the dominion of the Pharaohs, are retreating before the march of civilisation. Our obelisk will be erected at a period when British valour and enterprise have completed the discovery of the sources of the Nile; just as the mighty Congo has been traced to the Atlantic, and the heart of Africa opened up, ready to receive the blessings of religion and civilisation; when a prominent French engineer has severed the isthmus which connected Africa with Asia; and when British officers under the Khedive are employed to open up a highway to the Equatorial lakes. You will now hear a paper from a learned Egypologist, Mr. Basil Cooper, who has most kindly responded to our invitation, and who will now give you a very instructive description of these obelisks, together with their relation to chronology and art.

The paper read was:—

EGYPTIAN OBELISKS AND THEIR RELATION TO CHRONOLOGY AND ART.

By Basil Henry Cooper, B.A.

The African Section of the Society for the Encouragement of Arts, Manufactures, and Commerce may certainly be congratulated upon having within its wide Patriarchate so fair a Metropolitan province as Egypt. The present audience need not be reminded of the great share that country took of old in the civilisation of mankind. More, perhaps, as the beating heart whence came ever widening, if withal feebler, pulsations of life, than by direct influence, it woke up the other continents at the earliest dawn of history. Nor can we help looking forward as well as backward. Surely Egypt's great past may well kindle in our breast the brightest hopes, as it affords the most cheering presage, of what Africa may yet become, when the wonderful discoveries made in our days by Livingstone, Cameron, and Stanley shall have fairly roused us, as they can hardly fail to do, to pay

at length with interest the heavy debt we owe her.

Egypt is the monumental land, and amongst her most characteristic monuments are her obelisks. From the earliest times they were reared in pairs at the entrances of tombs and temples, the monotony of whose long horizontal lines these handsome upright shafts broke, in deference to a true instinct of architectural art. Had they not been thought things of beauty they would not have been carried off to adorn Nineveh, Rome, Constantinople, Paris, and London. Nearly all the obelisks we know or read of were cut from that ridge of fine granite, very free from flaws and shakes, through which the Nile ploughs its way, nearly under the tropic of Cancer, to form the first cataracts. The ancients called it Syenite, after the place, now Assouan, near which were quarried during thousands of years these monolith needles of flame-coloured stone, which Pliny tells us were meant to represent the rays of the sun, and were dedicated to that divinity. They were the oldest idols, and he was the oldest Egyptian god thus worshipped. They have been defined as rectangular prisms tapering upwards and culminating in a pyramidion, which rose about one-twelfth the whole height, and each was placed on a pedestal, also said to have tapered, which was about another twelfth. As early as under the Fourth Dynasty they are seen on the tops of truncated pyramids, and occasionally even surmounted with the Sun's Disk. This renders the notion of the imitative Solar Ray more intelligible. We are to think of a broadening beam of light shot downwards by that luminary. We are thus helped to look at the Great Pyramid itself—comparing it with the little pyramid, which crowned every obelisk—as representing the flood of sunshine in which the mummy of Cheops lay basking in hope of a final resuscitation. The religious idea best explains the fact that the obelisks were always monoliths, each a single stone, not built up bit by bit, like our modern imitations. Neither cost nor toil was to be spared on an image to be consecrated to the god. Hence, too, the care with which they were polished, and the consummate art with which the Egyptians provided against a drawback thence arising. They had observed that the play of light upon a polished surface made it seem concave, although perfectly level, and they accordingly gave the faces of their obelisks a degree of convexity exactly proportioned to this optical illusion. The French mathematicians have estimated this convexity in the instance of the Paris obelisk at 16 lines at the centre of the arc. Modern engineers, with hydraulic lifts and other mighty machines at their command, are still the first to marvel how these Titans of old managed to coax such enormous monoliths out of the quarry, to lug them such prodigious distances, not always by river or canal, from their stony bed, and then to rear them on their pedestals. The indications afforded by the unfinished obelisk, between 30 and 40 yards long, still *in sitû* at Assouan, are thought to shed much light upon the problem of extraction. The form of the obelisk, it seems, was first roughly outlined by cutting longitudinal gashes in the granite rock. Three of the sides were then pared into shape and polished, whilst the fourth was left still clinging to its native bed. To detach the shaft in its entirety, deep grooves were cut lengthwise underneath, into which were squeezed wooden wedges. These wedges, being moistened, swelled, thus loosening the stone. On drying, they were squeezed further in, and again wetted; and this process, being often repeated, split the granite at last, without any shock, in the direction wanted. This method seems preferable to that adopted by the Hindoo quarrymen to separate the Seringapatam obelisk, as described by Sir John Herschell. In that instance, the groove was intensely heated, and then suddenly filled with water. The Egyptians next dragged the obelisk out of the quarry, laid it upon a sledge, and, plenty of water being poured upon the sandy path along which it had to travel, in order to harden the ground, the monolith glided along, drawn by large relays of men and animals. For water carriage it was brought to a dock by the riverside, laid on a raft between two heavily laden barges, which being afterwards lightened, it floated down the Nile at the next inundation. How the Romans transported obelisks by sea—to be sure, not across the Bay of Biscay—we have scarcely any details; indeed, none to speak of. Pliny (H. N. xxxvi. 9) says ships were built for the purpose. He adds that Augustus ordered that which brought the first—therefore, either the Flaminian, or that in the Piazza di Monte Citorio—to be laid up for ever afterwards, as a marvel, in the dockyards at Puteoli; so it was evidently deemed an immense feat. In Pliny's time, Augustus's obelisk ship had been already burnt. On the pedestal of the Atmeidan obelisk at Constantinople there are some bas-reliefs which seem to refer to its transhipment. In a paper lately read before the British Archæological Association, Dr. Birch was in some doubt whether what is represented there is an ordinary Roman galley, or something so like Mr. John Dixon's cylinder ship as to give that gentleman good reason to look to his laurels.

The question of the erection of the obelisks in ancient and modern times is one far too large and too difficult to allow of more than a bare mention here. Most likely it was not until after they had been reared that the engravers began their toilsome work, scaffoldings being used for the purpose. They patiently inscribed the hieroglyphical texts, as drawn up for them, doubtless in the hieratic script, by the priestly colleges. How the workmen's bronze gravers were hardened for the task, and whether they used emery, are questions more easily asked than answered. Anyhow these sculptures deeply cut in the granite are marvels of antique art, especially those *incavo relievo* hieroglyphs, sometimes seen on these monuments, but only by those who look for the feathers of birds and the like conscientious details wrought out with the utmost finish below the surface of the stone. After all, however, the greatest miracle is the invention of these oldest symbols of speech, and the next greatest is their interpretation after the secret had been so long lost.

The Egyptian obelisks are written, and therefore historical, monuments in the strictest sense of the term, an immense advantage which they share with the Assyrian, such as the black obelisk from Nimroud in the British Museum, set up by Shalmaneser II, on which the learning and genius of the late Dr. Hincks first read

out the record of the tribute paid to that monarch by Jehu, King of Israel. They thus rank far above those Keltic obelisks, called menhirs, and other rude monoliths of a like kind found in India and elsewhere. So long indeed as the key to the decipherment of the hieroglyphics remained lost they were kept out of their birthright, and were like the Pharaoh Anysis, of whom Herodotus writes, driven from his throne to take refuge in the swamps of the Delta. But it should not be forgotten that even during the time of ignorance they pointed like fingers, or like notes of admiration, to the treasures hidden in the stone literature of the Nile. The obelisks brought from Egypt by the Roman Emperors, two of them by Augustus himself, and set up in the capital of the world, were thrown down during the barbarism of the Middle Ages. But after the Revival of Letters they were set up again by the Popes, first and foremost by Sixtus V., who found plenty of work of the kind for his engineer, Fontana. The strange picture-writing on them piqued the curiosity of the learned world, and guessing was rife for two centuries. But the chief gain was that the problem was now fairly posed, and that research could no longer sleep. For the guessers were all on the wrong scent, and there was as yet nothing to set them right. There was a settled belief that the Egyptian hieroglyphs, like the Mexican picture-writing, stood for things, either directly or metaphorically, instead of painting sounds, like the letters of the alphabet. The Jesuit Father Kircher was the great authority on the subject. He had studied Coptic, the latest form of the old Egyptian language, and, on the strength of this accomplishment, was most illogically credited with knowing all about the matter. Hence he was implicitly trusted when he proved by his ideographic translations of the obelisk inscriptions that they revealed the hidden wisdom of Egyptian philosophy and theology, which of course turned out to be miraculous foreshadowings of Tridentine Christianity. It was not until the dawn of our century that the discovery was made which was destined to puff away such airy nothings like the mists before the breath of the morning. The allusion will be understood to that famous Kaaba of all pilgrims to the British Museum, the Rosetta Stone. In 1799, it was found in the ruined temple of the Egyptian god Tum, built by Pharaoh Necho. The finder was M. Boussard, one of the *savants* accompanying the French expedition to Egypt. At the capitulation of Alexandria it was surrendered to General Hutchinson, and was soon afterwards presented by George III. to our national collection. The transcendent worth of this black stone lay in the fact that, for the first time, it gave us an Egyptian inscription translated into Greek. The Egyptian is written here in two scripts, viz., the hieroplyphic or monumental, and the demotic or popular, called also enchorial. What is thus engraven in two languages, but in three scripts, is a decree made by a synod of priests at Memphis in honour of King Ptolemy Epiphanes, which is ordered to be inscribed in this threefold form, and set up in all the Egyptian temples of a certain rank. Here, then, was the Archimedean fulcrum found, if this unknown world was to be stirred at all. The Archimedes, who, however, had to be waited for for some time, was the Englishman, Dr. Young, as the illustrious countryman of Champollion, M. Arago, frankly owned in his noble "Eloge" on his compatriot delivered before the French Institute in 1832. On the other hand, none is more keenly alive than our own Dr. Birch, whose sure lead this sketch follows, to Young's halts and shortcomings, after taking the first step. As compared with Champollion, he was but as Newcomen to Watt. Already before the Rosetta Stone changed hands it had been made known and reproduced in drawings by the French *savants*. From the first it was seen that the proper names *could* only be written phonetically, as they are in Chinese, and Silvestre de Sacy pointed out the groups in the demotic inscription which he thought must answer to the oft-recurring name Ptolemy in the Greek. In 1802, the Swedish scholar Akerblad resolved these demotic name-groups into the supposed component letters. Comparisons of this kind were much easier with the demotic, which was three times as complete as the sadly truncated hieroglyphical text. Besides the recurring names Alexander and Alexandria, the demotic presented the group taken to mean king 37 times, and that identified with Ptolemy 14 times. But as to the hieroglyphs, save for guesses by the elder De Guignes, and by Zoëga in his great work on obelisks, that after all they might be phonetic, nobody had as yet fairly grappled with them, with the view of testing this hypothesis by the touchstone of the Rosetta. Long after the discovery of that monument, the porch of the temple at Dendera was said to be inscribed with the 100th Psalm, and so late as 1821 the inscription on the Pamphilian obelisk at Rome, now known to have been set up by Domitian, was held to record the victories of the godly over the wicked under the sixth and seventh Pharaohs, B.C. 4,000. Meanwhile, Young had approached the philological problem in the spirit of the profound mathematician that he was. He began with the demotic, like the rest, and, unfortunately, he clung to it to the last. But, having been much struck with a suggestion thrown out by Professor Vater, who thought the unknown language of the Rosetta might be resolved into an alphabet of about 30 letters, he studied demotic and hieroglyphic texts alike, from the point of view of the phonetic principle. Having verified the identification of the demotic group for the name Ptolemy, by measuring the relative intervals as compared with the Greek text, he proceeded to test in like manner Zöega's notion that the ovals in the hieroglyphical text contained the same royal name. The result of applying this mathematical test was that he was now perfectly certain that within that oval was spelt—for it could not be painted—the name Ptolemaios, as in the Greek. He next proceeded to assign to each character within the oval its several function. Here he erred in some details, but in the main he was successful. He afterwards analysed another royal name, which he rightly identified with Berenike. But here also he failed in detail, and Dr. Birch, while admitting that he made out the true value of five characters, adds that "he was unable to analyse by his results more than these two names." In all his other attempts he utterly failed, mistaking *Autokrator* for *Arsinoe*, and *Kaisar* for *Euergetes*, not to speak

of other failures, all due to his clinging to the leading-strings of the demotic. It was in 1818 that he thus found the key, although it was left for Champollion to turn it more deftly in the rusty lock, and to open the door. It was not until three years afterwards that the French *savant*, although he had published his "Egypt under the Pharaohs" in 1814, and had served an apprenticeship of full seven years in the research, became acquainted with the new phonetic method of reading the hieroglyphics. But in January, 1822, Mr. W. Bankes, who had already forwarded to Letronne a copy of the Greek inscription on the base of his small obelisk from Philæ, transmitted to the same great scholar a copy of the hieroglyphics on this shaft. These were shown to Champollion, whose genius at once saw in the new materials the means of further verifying and enlarging the English discovery, of which he had by this time become aware. For besides Ptolemy's oval or *cartouche*, as Champollion christened it, there was on the shaft of the obelisk another, which could only be that of Kleopatra, since these two were the royal names found in the Greek below. His parallel analysis of the two was published in his celebrated Letter to M. Dacier, which appeared in September the same year. Prefixing the two *cartouches*, it will be a safe and easy task to follow the bold and firm steps of the master. The queen's name stands before the king's as that which Champollion was the first to read out.

Champollion's comparative analysis of the two names was as follows:—1. The first sign in the name Kleopatra he took to be the knee, the coptic word for which, *keli*, begins, like our English word, with K. The knee stands for K on the principle of our primers, which teach the child A by an apple, and B by a bull. In Ptolemaios there is no K, and accordingly there is no such sign in the second cartouche. 2. The lion, in Coptic *laboi*, is the second sign in the first *cartouche*, and the fourth in the second, just as L, the initial of the Coptic word for lion, is the second letter in Kleopatra, and the fourth in Ptolemaios. The Lion, therefore, is indisputably L. Here Champollion corrected Young's rendering of the second cartouche, whose third sign Young treated as silent, whilst he as strangely read the Lion OLE. 3. The third sign in the first oval is the Reed, *ake* in Coptic. In the other oval the Reed doubled stands in the sixth and seventh places, answering to the dipththong AI. In the Kleopatra cartouche it is plainly A or E. 4. The fourth sign is a kind of Noose, which must be the fourth letter O in Kleopatra, as it is the third in Ptolemaios, answering to the Noose in the third place of the second cartouche. 5. The fifth sign in the Kleopatra oval, a Mat, is P, the fifth letter in the name, and the first in Ptolemaios, in the oval for which the same sign accordingly stands first. 6. and 9. The Eagle occurs twice in the Kleopatra cartouche, not at all in the other. The Coptic word for eagle is *akhoom*, with initial A, and to the eagle in the 6th and 9th places in the queen's oval answers an A in each of the coreesponding letters of the name. 7. The seventh sign in the queen's cartouche is the hand, in Coptic *toot*, with initial T, just as T is the seventh letter of her name. This is not the same sign with that which stands for T in the Ptolemy oval. But it was soon found that the Egyptians had more than one T, and so of other letters, just as we have several signs for S, not all of the same origin. One of them, our crotchet S, is plainly a lineal descendant from the S which Young rightly read at the end of the first hieroghyphical word ever deciphered. 8. A mouth, in Coptic *Ro*, fills the eighth place of the first oval, and accordingly its initial, R, is the eighth letter in Kleopatra's name. The ninth and last letter has already been accounted for. But beyond this, the queen's cartouche presents the sign which stands for T in the name Ptolemy, which Champollion here rightly took for the Coptic feminine article, and the Egg which was also found at the end of other female names, and did not seem essential to the sound. In fact, the egg was afterwards proved to belong to the large class of determinative signs, none of which are sounded. as such, although a very few of them (this egg itself happens to be an instance) now and then discharge a phonetic function too, as syllabic signs. Of these syllabic signs, of which there are about 150, with the determinatives, which number half-a-hundred more, the long list of hieroglyphs, at which freshmen in the study so often take fright, is numerically all but quite made up. But, after all, the alphabet, as soon settled for ever by Champollion, with its 15 sounds and about twice as many signs, makes ample amends, by its millionfold employ, for the paucity of its letters. It spells not only proper names, but every kind of word, and the syllabic and ideographic signs are dumb until it bids them speak. The Egyptian scribes often pictured a horse simply, and without more ado, to denote that animal, but never before training the reader to associate that picture with its Egyptian name, by habitually spelling that name before it. Of course, when both word and picture were given, the word was not sounded twice; but no less certainly when nothing save the picture was given, it was sounded once. Never was an unfamiliar object written about, without both depicting it and alphabetically spelling its name. Of the vast Ygdrasil of Egyptian literature, the alphabet is the root, and all its ramifications Champollion had followed thence before he was laid to rest under his obelisk in Père La Chaise in the spring of 1832. *Requiescat in pace.*

The unravelling of the Egyptian graphic system, that masterpiece of the national art, first made possible something like a restoration of the authentic history of the Pharaohs. But the life of history

is chronology, without which it becomes mythical, shadowy, dead. Plato shut the door of his study against all unversed in mathematics. Of the science of the past the time-scale is the mathematics, without which it is not possible to know it aright. Unfortunately the Egyptian time-scale remains to this day hardly less the plaything of subjectivity than was the problem of hieroglyphical decipherment before the time of Young and Champollion. You need not be reminded of the thousands of years that yawn between the extreme dates given still for Menes, the founder of the Pharaonic monarchy; nor of the many hundreds between those for Usertasen I., whose obelisk, still standing at Heliopolis, is by far the oldest of the colossal order known; nor of the fewer centuries, but still quite enough to bewilder earnest students, between those for the Thothmes and Ramses, who have written on our Needle their own glorious names.

The second generation of hieroglyphists is passing away, and that is where we are at present. But let us hope on. We have seen how the mutual light shed on each other by the Rosetta Stone and one of the lesser obelisks cleared up the darkness in the one instance. What if it should be reserved for the same bilingual monument, by enabling us to understand an all-important note of time found on several of the greater obelisks, to break at last the secret of the lost chronology, as it before loosed the string of the dumb Egyptian tongue? It has taught us to read. It may, perhaps, teach us to cipher.

Of these greater obelisks Professor Erasmus Wilson—to whose genial pen, as well as to his open heart and purse, all interested in these monoliths are so deeply indebted—reckons we have a dozen left. He includes in this class all 50 ft. high or more. The line may be somewhat arbitrarily drawn, but it may be worth remarking that those he enumerates are wont to be styled "great" in their own inscriptions. Five are still in Egypt, viz., two at Karnak, and one each at Luxor, Alexandria, and Heliopolis. Four adorn Rome. These are the Lateran, the Vatican, the Flaminian, and the Campensis, as Ungarelli calls that of Psammetichus II., which Augustus erected in the Campus Martius, and which now stands in the Piazza di Monte Citorio. The other three belong, respectively, to Constantinople, Paris, and London. Since there are two pairs amongst the dozen, viz., the Paris obelisk, with its widowed mate at Luxor, and the two Cleopatra's Needles, they represent but ten distinct erections. Now, according to the inscriptions, four of these ten erections took place on the First Festival of some one or other Thirty-year cycle. Usertasen's, at Heliopolis; Queen Hatasu's, at Karnak; our own Needle; and the Campensis, at Rome, are all thus dated. Of a fifth erection, that of the Flaminian obelisk, judging from other inscriptions as well as its own, the same thing is morally certain. Thus half of our dozen colossal obelisks are strictly chronological monuments, and the erections—unless any two or more were coincident in time at least, although not, it may be, in place—must have occurred at intervals of just 30 years, or of multiples of that number of years. Yet, but for the Rosetta Stone, we should never have known this interesting and important fact. Its interpretation of the chronological notation which we find on these great obelisks, as well as on other Pharaonic monuments, is our only warrant for connecting it with recurring periods of thirty years, or trentenary cycles. There is here no hieroglyphic for either "years" or "thirty," but only for festivals of a certain kind, called, in Old Egyptian, *hibu set*, "festivals of the *set*." By this word *set* has been understood intercalation; *e.g.*, by Brugsch Bey, who formerly took them to have been those of a day every fourth year, as in our leap years. He has lately abandoned this view in favour of the hypothesis started by his learned countryman, Dr. Gensler, of Weimar, who, though without the least attempt at proof, assumes the trentenary cycle to have been a luni-solar one, with eleven intercalations in all, each of a lunar month.

I too think *set* here means intercalation, and that there were eleven such in each cycle, or very exceptionally twelve. This latter number I have found mentioned in a festival list inscribed, under the Twelfth Dynasty, in the tomb of Chnumhotep at Benihassan. At Silsilis are recorded all the intercalations belonging to one cycle, from the first, which took place in the 30th year of Ramses II., to the sixth, which fell in his 45th. In an Anastasi papyrus another, which must have been the ninth of the same series, is dated on the 26th of Mechir in his 52nd year. This evidence strongly supports the conclusion that there were eleven intercalations in all.

But so there are eleven intercalations—of a day, however, not a month—in a modern trentenary cycle, which deserves to be compared with the ancient, and which Lepsius, in discussing the latter, about such a cycle ago, when he wrote his great work on the "Chronology of the Egyptians," did not forget to mention. So far he may be held responsible for my rushing in where he did not himself dare to tread. I venture to maintain that "the thirty year cycles," of which, on the Rosetta Stone, Ptolemy Epiphanes is said to be "lord, like Ptah, the great," are still in use all over the Moslem world. The Hejira starts from the first day of one of them. But, as Ideler long since proved in his "Hand-book of Mathematical and Technical Chronology," they were in use in Arabia ages before Mahomet was born. He would not have erred had he said several thousand years. There, in the Sinaitic peninsula, Egyptian monuments of the Sixth Dynasty vindicate for them an antiquity stretching back to the fourth millenium before the Christian era. The cycle consists of thirty free lunar years, as Ideler styles them, of which eleven—viz., the 2nd, 5th, 7th, 10th, 13th, 16th, 18th, 21st, 24th, 26th, and 29th have an intercalary day added at the end to the other 354 days. Thus the cycle numbers $354 \times 30 + 11$ days, or 10631. This simple device of the elevenfold intercalation of a day is to cover the excess of the lunation over $29\frac{1}{2}$ day; and so well does it perform its function of keeping the kalendar moon true to the heavens, that the error does not exceed a day in, say, the space of time that has elapsed since the Christian reckoning began. The ancient Egyptians, as we have seen, kept these intercalations as festivals, the *hibu set*, and I have observed that the Pharaoh's coronation was always solemnised on the Neomenia thus inaugurated, *i.e.*, on the morrow of the intercalation.

It is now fifteen years ago since I first noticed the striking fact that, between the hieroglyphical dates, recorded in the Sinaitic peninsula, of the First Intercalation Festival of a Thirty-year Cycle, on the 27th of the eleventh month in the 18th year of Pepi I., a Pharaoh of the Sixth Dynasty*, and the First Intercalation Festival on the 3rd of the second month, in the 2nd year of the king, identified by Baron Bunsen with Mentuhotep II., of the same dynasty†, the interval is exactly six such cycles as the Moslems use, or 6 × 10631 days. The calculation takes account of the otherwise attested state of the Egyptian civil kalendar at that early epoch, which had then but twelve months of 30 days each, or 360 days in all, the five *epagomenæ*, or "added" days at the end, not having been introduced before the Twelfth Dynasty. The years of Pepi, or Phiops I. and Mentuhotep II., were still what my learned and lamented friend, the late Dr. Hincks, who took a deep interest in my researches, and agreed with me in the main as to this thirty-year cycle, was wont to call anepagomenic. With this interval of just six Moslem cycles between the two Pharaonic dates tallied the interval recorded by Manetho's existing text, as checked and rectified by Eratosthenes on the one hand, and by the fragments of the Turin Pharaonological Papyrus on the other. The comparative criticism brought to light a deficit of a couple of reigns, one of 10 and the other of 20 years, in our present copies of the Egyptian priest's list of the kings of this dynasty. It should be added, however, that one copy makes the kings eight in number instead of six, which so far confirmed my criticism. Shortly afterwards, it struck me that 1447 anepagomenic years contained but one day more than 49 of the Moslem cycles, so that by assigning a twelfth intercalation to one of them, say the 25th for symmetry, I could make another chronological experiment. This was to tabulate an anepagomenic period, beginning with the first day of a first trentenary cycle, and ending, on the 360th day of the 1447th year of the period, with the last day of the 49th such cycle. Of course all I cared to mark in my table was the month and day in the anepagomenic kalendar, on which, according to the Moslem rule, the first intercalation in each thirty-year cycle would fall, so that the results might be compared with the Sinaitic dates. Here is the Table:—

Table of the Anepagomenic Period of 1,447 *years of* 360 *days, showing the day of such year on which the First Intercalation of each of the* 49 *Thirty-year Cycles therein contained would fall.*

I.—xii.	19	XVI.—xii.	4
II.—vi.	30	XVII.—vi.	15
III.—i.	11	XVIII.—xii.	26
IV.—vii.	22	XIX.—vii.	7
V.—ii.	3	XX.—i.	18
VI.—viii.	14	XXI.—vii.	29
VII.—ii.	25	XXII.—ii.	10
VIII.—ix.	6	XXIII.—viii.	21
IX.—iii.	17	XXIV.—iii.	2
X.—ix.	28	XXV.—ix.	13
XI.—iv.	9	XXVI.—iii.	25
XII.—x.	20	XXVII.—x.	6
XIII.—v.	1	XXVIII.—iv.	17
XIV.—xi.	12	XXIX.—x.	28
XV.—v.	23	XXX.—v.	9
XXXI.—xi.	20	XLI.—iii.	10
XXXII.—vi.	1	XLII.—ix.	21
XXXIII.—xii.	12	XLIII.—v.	2
XXXIV.—vi.	23	XLIV.—x.	13
XXXV.—i.	4	XLV.—iv.	24
XXXVI.—vii.	15	XLVI.—xi.	5
XXXVII.—i.	26	XLVII.—v.	16
XXXVIII.—viii.	7	XLVIII.—xi.	27
XXXIX.—ii.	18	XLIX.—v.	8
XL.—viii.	29		

* Lepsius, Denkmäler, II. 115. † *Id. ib.* II. 149, c.

I own that, although the chances were more than 7 to 1 against me, had accident only been concerned, I was fully prepared to see the hieroglyphical dates turn up in the Table, as is found to be the case. But, to my amazement, the Phiops monumental First Intercalation came to light as that of the the last cycle but one, and the Mentuhotep date accordingly for the fifth cycle of a new period. This showed that if, as could hardly be doubted under the circumstances, the Anepagomenic Period was in use amongst the ancient Egyptians, it must have been already known to them about fourteen centuries at least before Mentuhotep's time, which carries us back beyond Menes. The first person to whom I made known these results—the year was 1863, and the place the library of the British Museum, with these hieroglyphical texts in Lepsius's great work open before us—was the profound Egyptologist who has so lately passed away, Charles Wycliffe Goodwin. The linguistic, rather than the chronological, research was his line. But he was fully alive to the great importance of the latter, and strongly urged me to persevere. Our acknowledged master in the science, Dr. Birch, with a like genial appreciation of an enthusiasm not his own, did the same.

The nature of the Egyptian Thirty-year Cycle, the crucial experiments on the Sinaïtic dates seemed to make pretty clear. It was the *alter ego* of the Moslem cycle of thirty times twelve moons. Subsequent research convinced me that this oldest form of the Pharaonic trentenary cycle—for, when it had to be grafted on Amenemha I.'s new kalendar of 365 days, its epoch was shifted some months, not to speak of other changes—was virtually the *idem ego* of the Arab reckoning. If it be so, there surely was never a more startling illustration of the proverbial immobility of the East. It would seem that the lunar computation current at this hour in the mosques must be at least verging towards the eighth millenary of its age. But your time and kind attention must not be taxed with the details of the solution of the terrible problem which was still behind—that of the recovery of the lost Anepagomenic Kalendar, of which one might well have despaired. For hopelessly lost it seemed to be at first, although I have since found its New Year's-day directly equated with a monumental date of our great obelisk Pharaoh, Tholhmes III. The date in question is the 21st of the month Pharmuthi, in the king's second year, answering to the 23rd of April, B.C. 1513. This was found to square exactly with the conclusion, reached by a quite independent road, that the Sinaïtic monumental date of Phiops I. answered to the 9th of March, B.C. 3568, and, consequently, that of Mentuhotep II. to the 28th of October, B.C. 3394. From the latter date, it may be of interest to observe, in passing, there are

but a dozen years to the end of the Sixth Dynasty. There, the Turin Pharaonological Papyrus gives a total sum of [1]355 years from Egypt's protomonarch, Menes, when we restore the missing 1000 of which a hole in the fragment has robbed us. According to this, his accession was B.C. 4736. By extending far enough downwards the table of the Anepagomenic Period, from the epoch just given for the First Intercalation Festival, in the reign of Mentuhotep II., its 45th cycle will be found to coincide fairly enough with that from which the Hejira starts, on June 15-16, A.D. 622.

Let me now return to our Needle, on which, in October last, Dr. Birch first read out from Burton's faulty text, the important trentenary date, since verified by a photograph, on which it was set up by Thothmes III. The three distinct, but convergent lines of astronomical evidence for my chronology of that Pharaoh's reign are developed in an Appendix, written at the request of the Chevalier Ernst von Bunsen, and published in his "Chronology of the Bible" four years ago. On this evidence ultimately rests my daring identification* of the day of the double erection of Queen Hatasu's pair of obelisks at Thebes, and her brother's Heliopolitan pair with the 28th of August, B.C. 1502. It was the First Intercalation Festival of the Cycle. How now stands the reckoning in the rear from the like festival under Mentuhotep II.? Measure off 65 cycles from the 28th of October, B.C. 3394, and the line strikes the year. If it fails to hit the month it is because of the shifting of the epoch of which I have already spoken. To test the calculus in front, let us start from the era of Menophres, mentioned by the Alexandrian astronomer, Theon. According to Dr. Hincks's rectification, it begins with the heliacal rising of Sirius, or the Dog star, on the Egyptian New Year's-day, 20th July, B.C. 1323. Dr. Hincks, moreover, exploded Champollion-Figeac's premature identification of this important Pharaoh with Menephtha, the son of Sesostris, or Ramses II., to whose grandfather, Menophres Ramses, who reigned but 16 months, he further proved it to belong. Thence it is but a step, the 54 years reign of Sesostris's father, Seti, to the reign of Sesostris himself, beginning B.C. 1269. Within the few months of the joint rule of father and son, falls the date of the famous Quatercentenary Stela found at San, the ancient Tanis or Zoan, the old Hykshos stronghold. Accordingly, it reckons by the Hykshos kalendar, falsely attributed to Augustus, who is thought to have introduced it, along with his Alexandrian era of Actium, which begins with its New Year's-day, the 30th of August, B.C. 30. But no ancient author tells us this, and the alleged coincidence, in that year, of this New Year's-day of the fixed Egyptian year of $365\frac{1}{4}$ days with that of the wandering year of 365 days only, which is the solitary argument adduced to prove Augustus's claim, did not take place, as Ideler has pointed out, until five years afterwards. In point of fact, the first of the Cæsars had already, under the guidance of the Egyptian astronomer Sosigenes, made this fixed kalendar the model on which he framed the reformed Roman kalendar named, after him, the Julian. He even, as my friend Professor Lauth, of Munich, has solidly demonstrated, borrowed bodily from this original, the Bissextile-day, which was actually common to both. I have ventured to term the invention Hykshos on the strength of a fragment from Manetho, preserved for us by the scholiast on Plato, which attributes to Salatis, the Shepherd King who conquered Egypt, the development of precisely such a kalendar, out of a previously existing lunar one, which, however, would not on that account be necessarily laid aside, especially by a Semitic race, such as these Edomite conquerors were. Salatis added, we are told, 12 hours to each month, and six days to the year, so that there were 366 days in all, as there would be in the first year of a bissextile reckoning. In the contribution already mentioned to the Chevalier Bunsen's work, I have given my reasons for believing that the Hykshos conquest of Egypt took place B.C. 2086. I hope, therefore, I may be forgiven if I see in the remarkable fact, that on the 30th of August in that year, the New Year's-day of the fixed kalendar, began the new Anepagomenic Period next to that under which the reign of Mentuhotep II. falls, a strong circumstantial corroboration of Manetho's testimony as to the introduction of that kalendar.

* In the *Graphic* newspaper of the 2nd inst.

Accordingly, I understand by the 4th of Mesori, on the San Stela of the 400th year of the Hykshos, King Sethos, which we already know to have been the first year of Ramses II., and the last year of his father, the 28th of July, B.C. 1269. The stela presents a slight indication, which has accordingly been too often overlooked, that this was the day of one of the eleven intercalations of a Thirty-year Cycle. This can only have been the First of the eleven, since several monuments make the First Festival of the Intercalation fall in the Pharaoh's 30th year, so that the same must have fallen in his first also, or B.C. 1269. Measuring forwards now eight trentenary cycles from the date assigned for the erection of our Needles to the San date, the line again strikes the year, but no more. The reason is as before. The San date belongs to the archaic series of cycles, and if we want an exact hit we must measure off 73 cycles from the the First Intercalation Festival under Menterhotep II., the 28th of October, B.C. 3394, and then we shall find the line striking the Edomite date, at the old Hykshos city, year for year, month for month, and day for day.

Of the almost certain fact that to this same first year of Sesostris belongs the Flaminian obelisk at Rome, with but one of its medial columns engraven by that king, whilst those of the other three sides were cut by his father, I have already spoken.

It is a pity that no one of the inscriptions which mention the Festival of the First Intercalation in the 30th of Ramses II. gives us the month and day, so that the testing computation of the intervening nine cycles between this date and that assigned to our Needles might have been exact. But we may well put up with the next best thing. In the course of this paper an Intercalation Festival, presumably the ninth of the eleven, which fell on the 26th of Mechir, in the 52nd year of his reign, has been cited. Here then is a fairly stringent test of my chronology, which gave the 28th of August, B.C., 1502, for the twofold obelisk erection. The Ramses date reduced is the 16th of December, B.C., 1219. How then stands the reckoning? In lunar time the interval is just nine thirty-year cycles

and twenty-two free lunar years to a day. Now, according to the current Moslem rule, if the former date was that of the first intercalation, the latter would be that of the ninth. It will be seen the sum works.

I have declaimed my multiplication table, and must crave your indulgence, if I have flirted too freely with figures, in the fond conceit, perhaps, that figures have smiled upon me. After all, I feel I have lifted but the fringe of a problem to the investigation of which we seem challenged by the great chronological obelisks, especially by our own Needle, and by the interpreting word, as I may again remind you, on the Rosetta Stone.

DISCUSSION.

Mr. Dixon said although the meeting might be unable on the spur of the moment to grasp the array of figures Mr. Cooper had laid before them, he had shown them clearly that those old historic stones possessed great interest, and that the investigations of such men as himself, and those he had alluded to, might yet educe from them important facts and dates which they could hardly expect. It would certainly be wrong to allow such monuments to go to decay, as it was impossible to say what they might not do for history. However, they knew sufficient of their value to justify the successful attempt to preserve one of the best of them, the most ancient and interesting, perhaps, of all, by bringing it to this country. They were at any rate great historical land-marks dating back over 35 troubled centuries, and connected with the names of some of the principal sovereigns and figures of past ages. He was afraid he should be unable to add anything very novel on the subject, and would leave that matter in the hands of the great Egyptologists present, while he felt sure that Mr. Cooper's entertaining paper would be considered well worthy of attentive perusal at their leisure. With regard to the vessel in which the obolisk had been brought to this country, so many had probably visited, seen pictures, and heard all about her, that but little explanation of the model before them would be necessary. It had done its work, which was the most that any construction could do, small and comparatively insignificant as it appeared, and those who had built her had, no doubt, carried out the wishes of Dr. Erasmus Wilson, and had answered the poet's invocation—

> "Build me straight, O worthy master,
> Staunch and stout, a goodly vessel,
> That shall laugh at all disaster,
> And with waves and whirlwinds wrestle."

The model of the obelisk itself had been prepared by his brother, and was as accurate as it could be made. It represented as nearly as possible the hieroglyphics and the battered condition of the stone, which it must be remembered had not been cut by a sculptor in very recent days, and those who thought to find in the obelisk a polished surface and well-cut inscription need not go to Cleopatra's Needle itself, but had better perhaps go to Bethnal-green, for instance, where they would see such things in abundance. The second model had been prepared to argue the point of site with the Metropolitan Board of Works, and it had succeeded in effecting the object intended, though as was known, they had failed in obtaining what most people considered the most eligible site, viz., in the centre of St. Stephen's-green. They had in fact failed, and always would fail, in procuring a site which would be satisfactory to everybody, and no doubt they had failed at Westminster for not improper reasons urged by the Metropolitan District Railway Company. The hoped-for site at the back of the Horse Guards they had also been obliged to abandon, on account of questions as to the future position of the new Government buildings and Admiralty and War-offices, which rendered it uncertain what the future shape and position of the Horse Guards' parade ground would be. Next to those the present proposed site appeared to offer the greatest advantages, and to be most appropriate, as it possessed a great mass of granite work, and was a thoroughfare which in a few years would be one of the busiest in the metropolis. Probably fewer objections had been made to the site of the Adelphi-steps than to any that had been proposed. The Metropolitan Board of Works would no doubt decide to add the sphinxes, and to reduce the two large and clumsy pedestals standing there. He believed the whole plan was practically settled, and the work would probably be commenced in the course of a week or ten days, of moving the obelisk into its place. The next model had been propared some time ago, with the view of illustrating what was then thought would be the simplest and best plan of erecting the Needle; but they had got wiser as they had grown older, and had made some improvements which would considerably modify that plan of erection. The stone would be taken in the ship and laid alongside the Embankment on a stage of timber, and ship and all would be gradually raised and rolled into place. Then the ship would be cut to pieces, and the obelisk gradually lifted into a horizontal position. An iron jacket would be placed round the middle of it, resembling the trunnion of a cannon, by which it would be suspended, then swung down into a perpendicular position by means of a small hydraulic ram, and then, by letting the water out, the stone would be lowered a few inches and left standing firmly on its pedestal.

Mr. Boscawen was unable to say much about Egyptian subjects, never having devoted much study to Egyptology, but as Mr. Cooper had referred to Assyrian obelisks he would venture to say a few words about them. There were three of them in the British Museum; the black obelisk, which was more or less perfect, of the time of Shalmaneser III., B.C. 3850, a portion of an earlier one of the time of Tiglathpieser III, and an intermediate one of the time of Assurnasabal. The Assyrian obelisks could in no way be said to resemble those of Egypt, and especially in the carelessness of the workmanship. In the black obelisk the lines were all out of the horizontal, and the sides of the monument were similarly faulty. Still the Assyrian were of far different origin to the Egyptian obelisks, having, probably, originated in the temple towers of Babylon, and were simply small monuments copied from those towers and erected in the palaces as triumphal columns. The Assyrian kings did not appear to have erected many, as no portions, or even traces, of them had been found boyond the three mentioned. During the later empire, when the Assyrian kings came into contact with Egypt, they seemed to have been smitten with the beauty of the Egyptian obelisks, and to have recognised their importance as a feature of decoration; so that, when Assurbanopal invaded Egypt, about B.C. 1364 (?), he carried away two obelisks from Thebes to Nineveh; but, as no trace of them had been found, they had probably been broken up and carried off during one of the later sieges of Nineveh. From the Ninevite inscriptions, however, it would seem that they had been covered with hieroglyphs, and were considered very valuable works of art for decorating his capital. The Assyrians were, in many respects, not an artistic people, but were quick in utilising the art of other nations, and in employing foreign artists in their work, in fact, much of the Assyrian art-work was done by Phœnician and Egyptian artists. Consequently the obelisk had never been worked out as a form of monument by the Assyrians, and no comparison could be instituted between those of Egypt and Assyria. That some form of column was very early adopted as a monumental record there could be little doubt, the old hierograph, represented by a straight stroke, probably showing that the straight stick or column was the earliest kind of monumental record attempted of men's existence and deeds, a supposition curiously borne out

by the fact that the word designating them meant simply "wood." Probably the first monuments of the kind were plain wooden posts, afterwards improved upon by being cut in stone, thus giving rise to the column; but certainly in early Assyrian times no trace of obelisks like those of Egypt could be found. In a chronological point of view Mr. Cooper had gone far back into the early history of Egypt, and had shown that in the earliest Egyptian monuments inscriptions were cut in purely phonetic characters, expressing a language with a fully developed grammar, and a certain amount of literary style and culture. Clearly, the growth of such a language was not the work of a few years, and it would therefore be necessary to go very far back indeed to find traces of mere primitive culture in Egypt, while in Babylon, going back 3,000 years, a much more primitive state of culture was found to have existed. They might, from this, fairly conclude that if ever they could get to the bottom of Egyptian history, it would be found that the Egyptian civilisation was much older than the Babylonian. Inscriptions being found of the second or third or any other dynasty written in a pure language, must show that it would be necessary to go far back indeed to find the period when the Egyptians first inscribed the pure hieroglyphic to convey their ideas from man to man.

General Sir James Alexander was gratified to see at last the famous Needle safe in the Thames, where it had been brought by the labour, skill, and energy of Mr. Dixon, who, there could be no doubt, would erect it in a suitable manner. That gentleman seemed to regret it had not been placed in St. Stephen's-green, but those who had seen the model there would have the consolation that it would not be obscured from the Thames Embankment by masses of buildings surrounding it, but would occupy there a much more commanding and conspicuous situation. He had himself been desirous of seeing the obelisk placed behind the Horse Guards, where it would always recall the names of Nelson and Abercrombie, and it was a pity the proposed new Government buildings should have deprived the monument of so appropriate a site. The proposals to place it in the Green or Hyde-parks were objectionable, as removing it to too great a distance from the river, in point of difficulty of transport and expense, as compared with the Embankment site. To the patriotic and disinterested offer of Dr. Erasmus Wilson, his fellow-Scotchman, was due its acquisition for England, and although it was often said the Scotch were very careful of their money, he had furnished a conspicuous instance to the contrary, which, there could be no doubt, was by all highly appreciated.

Dr. Mann, speaking of the comparative and apparent size of such a monolith, said that after the objections made to the Needle being dwarfed by the buildings surrounding St. Stephen's-green, he was never more surprised than at finding, on the contrary, that from the end of Great George-street even the great Victoria Tower was dwarfed by the obelisk. He would really advise those who entertained contrary opinions on this matter to carefully reconsider the impressions on which they had formed them, and he did not hesitate to say that the obelisk at Paris was more dwarfed where it stood than this would have been had the St. Stephen's-green site been fixed upon. The one thing he regretted in the selection of the present site was that the obelisk would not be so placed that the site might have been moulded to the monument, for what was wanted was a space where everything could have been made to tell in the ultimate effect. Under all the difficulties which had to be met, however, there were good reasons for the present selection, and there could be no doubt that the effect would be very fine, particularly from the river, and that when erected it would be seen, from close quarters, as a very grand and noble monolith.

The Chairman thanked Mr. Cooper in the name of the meeting, for his entertaining and elaborate paper, and congratulated Mr. Dixon on the successful and simple manner in which he had designed the vessel in which the obelisk had been carried, combining as it did easy means of floating the monolith, making the passage across the sea, and of landing it at last on our shores. It was in short, an admirable piece of naval architecture. The meeting were also much indebted to that gentleman, and to Mr. Boscawen, for their useful remarks.

Professor Tennant added, in reference to the materials of the monuments mentioned in the course of the discussion, that the Rosetta Stone was often erroneously described as being of marble, whereas, in fact, it was of basalt; two of the obelisks standing beside it in the British Museum were also of the same substance, though the black obelisk from Nineveh was of marble. Should the present proposed site for the erection of Cleopatra's Needle not finally be adopted, there were two others, either of which would be most appropriate for it, one, namely, at Greenwich and the other Chelsea Hospitals.

ELEVENTH ORDINARY MEETING.

Wednesday, February 20th, 1878; Lieut.-Col. Frederick E. B. Beaumont, R.E., M.P., in the chair.

The following candidates were proposed for election as members of the Society:—

Armstrong, Thomas, Highfield-bank, Urmston, near Manchester.
Christie, The Worshipful Richard Copley, M.A., Chancellor of the Diocese of Manchester, Uplands, Prestwich, Manchester.
Dees, James Gibson, Whitehaven.
Forwood, Arthur Bower, Mayor of Liverpool.
Grimsey, Benjamin Page, Stoke-lodge, Ipswich.
Knuttel, G., Delft, Holland.
Stürmer, Frances von, 25, Gloucester-road, S W.

AND AS HONORARY CORRESPONDING MEMBER.

De Ayala, His Excellency Don Ramon Lopez, Havanna, Cuba.

The following candidates were balloted for and duly elected members of the Society:—

Albano, Benedict, 75, Welbeck-street, W.
D'Avendaño, Don Teodomiro, 178, Hampstead-rd., N.W.
Farquharson, Robert, M.D., 23, Brook-street, Grosvenor-square, W.
Hutton, Darnton, care of Messrs. Henry Lee and Son, 5, Westminster-chambers, Victoria-street, S.W.
Liley, Henry G., 5, Bradmore-park, Dalling-road, Hammersmith, W.
Schwarz, Gustave F. C., Ph.D., High School of Trade and Commerce, Queen's College, Birmingham.

The paper read was—

MECHANICAL TRACTION ON TRAMWAYS.

By J. L. Haddan, M.I.C.E.

Before mechanical traction on tramways can be expected to attain the success to which its public convenience entitles it, it is absolutely necessary that the question shall be treated as such a radical change in locomotion deserves, the more so as we have positively no experience to guide our general policy; the railway, except in regard to small mechanical details, being not only inapplicable, but positively misleading. It is, therefore, imperative in this novel branch of engineering

science that the conditions to be imposed upon the machine and system generally, shall be clearly set forth, leaving it only to manufacturers to meet them in the most economical manner possible.*

The persons whose duty it is to impose these conditions are the following:—

A. The Board of Trade.
B. The Civil Engineer.
C. The Locomotive Superintendent.
D. The Traffic Manager.
E. The Public.

Owing probably to the gigantic strides made of late years in the production of machinery, by which the mechanic has enormously enlarged his influence on the solution of engineering questions, often in defiance of more natural means, the manufacturer has been allowed on railways to (supply engines which) impose highly extravagant and unnecessary conditions on the construction of the road, and even on the general policy of the system.

Every engineer now accepts that the following theories, although they will work, are anything but commercially sound, and should be abandoned when possible, viz., that—

1. Dead weight is a necessary power (adhesive) on a rising gradient.
2. Dead weight is a necessary power (brake) on a falling gradient.

If, therefore, on the moderate grades of a railway, made artificially so as to meet the limit allowed by the above theories, these main principles of railway traction are to be regretted, how much more so would it be the case were we to allow these tenets to influence tramway traction, where the grades are not only steeper but unalterable?

The engine manufacturer, therefore, is not the proper person to be entrusted with these grave interests. As tradesmen it is perfectly legitimate for them to advocate something which suits their plant, a condition which civil engineers far too often accept as a necessity; a fact which has done much to ruin export trade and the employment of the English civil engineer abroad, because the proper conditions which each case required were rarely imposed by the one or met by the other.

Thus it is we often see a trade catalogue employed as the text-book of the civil engineer, and details such as speed indicators, condensers, and so on, are allowed, as is already the case with tramways, to be considered as vital points, while the machine, under such shelter, is hurried into the market, bringing itself and all connected with it into discredit.

A rapid street transport service is beyond doubt a public necessity, especially in cities where no underground communication exists, or in districts not served by it. In Paris, especially, the service is fearfully slow, and must be accelerated; and since, owing to the magnitude of the sewers, and to the position of the Seine, no complete system of underground communication is possible, even if defensible, when the streets are so broad; and as viaducts, overhead railways, and so on, would spoil the architectural effects, there is no doubt that Messrs. Harding and Co. have been farsighted in commencing operations in that city, where steam traction has proved a commercial success.

Note.—Both underground and overhead lines are proposed, but they do not meet with public approbation.

In cities, however, where the streets are comparatively narrow, acceleration of the through traffic is positively a necessity, being probably the only proper means of relieving pressure; instance London-bridge and its approaches. If only the slowest and most ponderous waggons, which now choke the bridge and its approaches, were forced to use Southwark-bridge, the general stream of traffic could be so accelerated as never to jam, even if the traffic were twofold what it is.

So far as an irregular service is concerned, like the Cassel steam tramway, where the summer service is considerable and the winter service *nil*, steam has decidedly the advantage, as when not in work the engines cost nothing to keep; but, for regular traffic, it is only where considerable speed can be permitted, or in situations where greater loads or larger cars than two horses can really manage are required, that steam can compete successfully with horses.

Note.—It will be seen further on that two horses cannot work the present large car, so that the above remarks apply only to one-horse cars.

After 12 months' working with 25 engines running about 300 trains a day, the following are a few of the leading rules which the experience gained warrants, I think, my laying down with a certain authority, under the five headings before-mentioned:—

A. The Board of Trade.

1. The officers of the Board should have certain clearly defined executive powers, so as to insure their recommendations being properly carried out; the power of entire suppression, the only one they now possess, is too severe to be of any use, as it could not be applied severally to the innumerable details, the neglect of which affords such just grounds for public complaint.

2. Each company using steam shall be bound to furnish returns every month of the performance of the engines both active and passive, as also the amount of fuel, oil, &c., used; and in fact any information which shall facilitate future legislation on the subject, or supply reliable data, of which there are none.

3. The steam tramway traffic shall be worked in the opposite direction to the ordinary traffic, if a double line; with a single line this must naturally be the case in one direction.

Note.—This would prevent any vehicle from being run into behind, found from experience to be the cause of 80 per cent. of the street collisions.

4. In streets of less than ( ) feet in width no steam-car shall stop to take up or set down passengers.

Note.—If a tram does not stop in a narrow street, it performs good service in regulating the streams of up and down traffic.

5. On routes where the average width of streets is less than ( ) feet, steam-trams shall only take up passengers at certain defined points, but may, however, stop where required to set down.

* When railways originated, our mechanical skill and experience did not entitle us to lay down firm and fast rules; but surely now it would be highly reprehensible not to do so before it is too late; the capital already embarked amounting to £4,000,000.

Note.—Time is only an object to through passengers, and their interests should be more considered than the short-fare public, even if the above regulation had no other object in view.

6. In any collision taking place, except at a cross road, the public vehicle shall, *prima facie*, be held responsible.

Note.—The steam-tram cannot port or starboard while the public vehicle can. The course of the one is also known and can be anticipated, and therefore avoided; the course of the other cannot.

7. Any loaded waggon or cart, breaking down on the rails, and thus obstructing the tram-road, shall be deemed responsible, if it is proven that it could have circulated clear of the rails, and was not forced by the narrowness of the street, or other cause, to use the tram space.

8. On approaching all main cross roads used by omnibuses and trams, or where the traffic is considerable, the steam-trams shall slacken speed; and stopping stations, with this view, shall be as often as possible introduced at the arrival side of a cross road, and never be authorised elsewhere. Where cross traffic may be considerable, and it may not be deemed necessary to establish a station, then police caution notices to the general public shall be conspicuously posted.

9. To prevent undue speed, and insure a regular service, a time-table shall be drawn up, in which each departure and arrival snall be clearly defined, and each engine or car shall bear a distinguishing letter or figure corresponding to its own series of journeys. (See specimens on the table.)

Note.—By this means at any point on the line, or at any time of the day, the least irregularity may be detected by anyone of even ordinary intelligence, such as a policeman. This system has worked most successfully in Paris for over nine months, and kept the management continually on the *qui vive*, so that no driver exceeding the regulation speed stood any chance of escaping punishment.

10. As a further check on undue speed, the diameter of the driving wheels may be limited to two feet, so as to render quick speed wasteful, and therefore not likely to be encouraged by the management.

Note.—Mechanical control has hitherto been found useless; it is sure to be tampered with, and where the speed is estimated from the wheel circumference, wear in the tyres, and slip, would stultify the record.

11. The fire-box shall be of sufficient capacity as not to require the fire door to be opened either during the run or at a crowded terminus.

12. Superheating the steam and attenuating it will be provisionally accepted on suburban lines in lieu of condensation, provided the beat of the exhaust be completely silenced, no smoke is shown, and the chimney be carried up 15 feet above rail level, when outside passengers are carried.

13. In crowded streets no smoke or steam will be permitted to be visible.

Note.—Makers are informed that a perfectly boxed-in machine, which does not afford a full view of the drivers, are more likely to frighten horses than an open cab.

14. Gauge-glass cocks to be so arranged as to be self-closing in the event of a gauge-glass breaking, so that the exit of steam or hot water shall be instantly or automatically arrested.

Note.—The public are greatly alarmed on such occasions, so much so, that a French correspondent of the "Whitehall Review," with reference to a similar accident, stated that one of the Merryweather boilers had burst.

15. The fender back and front of the engine shall not be deemed suitable unless the clearance above the rails shall always be maintainable at the minimum, notwithstanding wear of brasses and wheels. This is usually allowed for by using a clearance so excessive as to be useless as a protection.

16. No movable points and crossings shall be used with steam traction, unless the needles be lockable, and no movable points of any kind shall be permitted in cases where the road can be laid (as it nearly always can) with fixed points only.

17. In all cases where the load exceeds the weight of the engine, or when two or more cars are coupled, either a special brakesman shall be obligatory, or a continuous brake, worked from the engine, shall be attached to the train.

18. The engine shall be fitted with such apparatus or appliances that, should it leave the rails, or otherwise break down, five minutes shall suffice to clear the road, with the assistance only of the staff of the train.

19. The running front of the engine shall be fitted with projecting reflecting lights; so that, not only a disc of light shall be shown, but the whole of the front of the engine, and 10 ft. of the roadway in advance, shall be brilliantly illuminated.

Note.—It has been found, from experience, that the distance off of so small an object as an approaching bull's-eye cannot be accurately gauged.

20. No machine shall at any time be left standing on the highway without its proper attendants, whose name or names shall always be conspicuously displayed on their engine.

21. No tram engine shall be allowed to be driven by one man where the variation of pressure shall range more than three atmospheres, or the fire require any attention, or lubrication be necessary, or the boiler require other than self-acting feed during a five-mile run, or any action be necessary which may necessitate the driver diverting his attention from driving.

22. In laying the pavement, the blocks shall be so laid as to define on the road itself the exact overhang of the tram vehicle, so that the public may judge to an inch when they are "standing clear."

Civil Engineers.

The grooved tram rail has been far too hastily adopted by the profession, seeing that compared with railway traction it will, when dirty, increase the tractive force about fourfold; which amounts, on inclines, to almost as much resistance as if asphalte were used.

In fact the only notable advantages a tram rail possesses over a smooth road, say of wood or asphalte, is that it affords direction, without which speed would not be feasible; but as this advantage is not made use of, the value of a tram rail is certainly not at present worth its cost, nor does it warrant the wholesale cutting up of first-rate roads, which experience shows us can never be kept in perfect repair afterwards, owing to the

great disparity in hardness existing between the rail and the road material. In America, where roads are bad and carriages few, this difficulty is sufficiently met by using a broad flat tread to the rail, so as to encourage carriages to run on the track itself.

I must qualify the above so far as to explain that though it is incontestible a pair of horses can pull more on a tramway rail than on a wood or asphalte pavement, when on the level; a gradient less steep than the mean of most tramways soon brings the two to an equality: and in some cities where the average grades are heavy, the horse traction on the wood would prove to be the lighter of the two.

It is a fact within my own knowledge that, on mounting the incline of the Avenue Josephine in Paris (1 in 25), the coachman applies the brake slightly, by way of affording relief to the horses in the pull-back on their collars, resultant of the effort of the car to recede.

In Paris, with the view of diminishing the traction, especially on sharp curves, the groove in the rail is allowed to be as much as $1\frac{1}{4}$ inches; but do what you will, however, to assimilate a tramway to a railway and obtain similar tractive facility on it, success is impossible, at any rate with a grooved rail.

1. The hard and clean railway track, rendered as it is so smooth as to prove even a positive detriment to the adhesion or foothold of the engine, cannot positively exist as part and parcel of a more or less soft and dirty carriage road. To ensure harmony between the track and the road it is necessary, therefore, to sacrifice a little tractive suavity in the rail, so as to be able to reduce the road and rail to the same standard. By using a wooden rail and pavement this end is obtained.

Since also in England the voice of carriage people is an all-powerful one, it is policy, were it not also economy, to make a tram-road according to the Act of Parliament, wherein it is enacted that the laying of the road shall not lessen in any way previously existing circulating facility. A wooden system alone can do this.

Since, however, the traction on a wooden rail would certainly be much greater than on a railway; it is not desirable in this case, or with grooved rails, or wherever the tractive force exceeds about 10 lbs. per ton on a level, to use the ordinary locomotive traction, and in humble imitation of the horse, pull the load.

The dirt and grit of a street, while obstructing the car, decidedly help the locomotive, and therefore by making all the wheels of the steam-tram motive wheels, it is evident than an extra smooth road is no longer a necessity.

There is, therefore, I think, no doubt that both on road tramways and on common roads the secret of success lies in abolishing entirely a drawn load, for which a perfectly smooth road is required, in favour of continuous driving, and its antithesis, continuous brakeing, a system which does not require too smooth a track, although it will work equally well on either—say on ice or on sand.

The advocates, therefore, of combined engines and cars are so far travelling in the right direction, but (1) they do not utilise more than 60 per cent. of their weight for adhesive purposes instead of the whole; and (2) the working objections detailed under the heading "locomotive superintendent," will be found insuperable. But to resume. The undue overhang of the cars produces violent longitudinal oscillations when drawn by steam; these shocks are not only disagreeable, but destroy the stock and road; the remedy hitherto has been the adoption of a long but flexible wheel base; but all the systems tried, without exception, were not at home at the tangents of the curves; for the pair of wheels first on the curve always skewed prematurely those remaining on the straight. This was a matter of small importance on railways where curves were generally of a respectable length, and Grover's and Cleminson's systems have done good service thereon; but on trams the curves are so short, and frequently S into the bargain, that they may be said to consist of nothing but tangents.

Cars for use with steam, if they carry outside passengers, must be greatly stiffened and braced longitudinally, since when the brake is suddenly applied below, it fails momentarily to check the impetus of the passengers up above on the roof.

In Brussels an articulated train, after the design of M. Dathis, a French engineer, will be tried in a few weeks. The engine is detachable, and the cars (or each articulation) have only one pair of wheels. The weight of the cars at the joints are supported by strong girder-like couplings, centred on the axles of each articulation. It is expected to work on curves of 20 feet radius.

Considering that in Paris streets one litre of water will thoroughly cleanse a square mètre at a cost of about 2d. per annum, it is surprising that tramway companies have not made joint arrangements to wash the streets. The saving in wear and tear to themselves and the general public, let alone the comfort, would amply justify the outlay.

Locomotive Superintendent.

1. For the sake of economy in repairs, no tram engine should run more than 10, or say 12, hours daily.

2. To ensure due care and economy in the driving, every driver must have his own engine and fittings, and no one else be suffered to touch them.

Note.—Even dinner reliefs were found impracticable; dirty fires, burnt brasses, &c., were the consequence, and the blame could never be fastened on the right shoulders.

3. During the day it was found necessary to sweep the tubes, and also to inspect and clean the machinery, as it could not be properly done, either morning or evening, in the dark.

Note.—Each engine, therefore, was brought in for a few hours daily, to rest the men, and see that all bolts, cotters, &c., were in place. This measure was, I may say, imperative, as breakdowns were previously principally due to such trifles as pins, &c., working loose.

4. Reliefs were performed by changing the engine bodily on passing the depôt, and therefore without inconveniencing the passengers; when, however, a car broke down, everyone had to change carriages, and the conductors were in despair as to who had paid and who had not.

5. Owing to the grease and dirt attendant on a running shed, it was found impossible to keep the cab in as decent order as the corresponding car; it was, for this and other reasons, abandoned in favour of an open iron weather shelter.

Note.—In addition to the above, which combined cars cannot comply with. the men must not be cramped; the public object to close proximity to steam; a huge car is not desirable, as it is not handy, and cannot be used on reasonably sized turntables; it must necessarily run half its life wrong end first, and therefore requires two men, one to stop with the machinery, and the other to drive from the front; the side entrances are also dangerous, and it requires greater power to start it. Existing roads cannot be used unless reversing stations and other modifications are made. Moreover, Mr. Rowan puts his tractive force at 1,500 lbs., a good result for such confined machinery, but as a like result has been obtained by a four-ton detached engine, it will be found that, $9\frac{1}{2}$ tons being the gross load in both cases, the advantage of the combined car is confined to only increased adhesion.

For these reasons I am decidedly of opinion that a detached engine is a *sinâ quâ non.*

6. Rigid under-frames should be condemned, as also crank axles, owing to the cross bending strains incident on an irregular road; coupling rods, because of the curves; and eccentrics and open axle boxes, by reason of the mud.

7. Volute springs have not been found to answer, the old **C** spring is far superior in distributing the shock.

8. Freeplay to the horizontal boiler, both laterally as well as longitudinally, is imperative, as, if fixed, it is so affected by the curves that the tube plates converge, and tight tubes are an impossibility.

9. The brake should never be applied on the wheels, but on false tyres readily renewable. They should be applied on both sides of the engine, and should not be arranged so as to strain the coupling rods, by either forcing the wheels together or driving them apart, nor should counter-balanced wheels be used. These remarks apply also to the cars.

10. The joint surfaces should be nearly double what is usual in a locomotive, owing to the constant use of the reversing lever and endless stoppages, which in other ways also tax the engine severely.

Note.—From actual trials in America with a goods train, each stoppage and starting was found to cost for fuel a two mile consumption. I estimate it for trams at half a mile, or 4 lbs.; stoppages average about 600 in number per engine during the day. With horses the duty absorbed in "starts" is as much as 25 per cent. of the day's work.

11. The steam chests should, as in Mr. Brown's Winterthur engine, be upside down, so as to drain the cylinders, and thus avoid the constant use of pet cocks. All the wearing surfaces should be excessive, and liners used wherever possible.

12. The machine must be powerful enough to push before it to the nearest siding any train which may break down, a duty which a combined car possessing a tractive force of 1,500 lbs. could not perform.

13. Side fire-doors are undesirable; they have been found to ruin the tube plates by admitting cold air currents.

Management.

Steam-tram traffic has to be managed on an entirely different basis to either horse-trams or railways.

Steam traction in Paris now pays 9 per cent., while the tramways and omnibuses are earning little if any dividend, although horse keep is cheap and fuel is dear.

On making the usual false comparison, viz., per mile only, instead of per mile in conjunction with the weight carried (receipts), which is the only fair plan, we find the cost in favour of horses. But when we reduce the competitors to the test of work done, as in column A., the result is greatly in favour of steam. See Table:—

Paris.—Table giving comparisons between Horse and Steam Fraction.

Classification.	Nature of road.	Working expenses per mile run.	Receipts per mile run.	Receipts per seat. averaging 0 45d. per mile, if full.	A. Working expenses per mile. Work done equal in all three cases.	
			s. d.	d.	d.	
Steam .	Steep	7·43	2 8	0·66	7·43	
Horse line .	Easy	6·40	1 10	0·46	8.49	Average 9·93
Horse line .	Steep	8·56	*1 $2\frac{1}{2}$	0·30	11·37	

The fares of the car of 48 passengers, when full, represented 3s. per mile on the line in question; but on certain days, owing to constant mutations, the earnings have been known to amount to 5s. 9d. per mile. The useless number of journeys run by the horses, and the value of the consequent extra dead weights may be fully realised on occasions when the receipts only averaged 1s. $2\frac{1}{2}$.* The cost of steam traction, with two full cars instead of one, is only increased $\frac{3}{4}$d. per mile for fuel and oil, which brings the cost per mile up to 8·18d. (in France), or less than horse traction on a far easier line with only one car.*

In Paris, on easy lines, 10 horses work one car per day, and do about 12 miles per diem; but with so large a car this number of horses would not suffice, if managers (with the view of showing a low cost per kilometre) did not relieve their horses, by giving them on an average less than half loads; that is to say, run double the number of trips necessary.

Note.—Morning and evening, when the trams are full, we must have noticed that two to three miles an hour is all that can be got out of the horses; full omnibuses can beat them hollow in speed. A tram-car, therefore, is too much for two horses.

I consider that 10 horses can readily work an omnibus with its load of 26 passengers, but 10 horses cannot readily work a tram (grades, &c., being equal) with a load of more than 35 passengers. A six-ton tram engine can work a load of 100 passengers. The running staff, in all cases, would cost the same, so the steam-tram ought to be able to carry passengers at one-quarter the omnibus fare.

Roulement.—The system adopted in Paris of *roulement* is devised for obtaining uniform and comparative statistical results, no matter how irregular the service. Thus, by the system of *roulement*, at the end of the month, each engine and driver will have performed precisely the same mileage, should also have expended the same

* An additional car run uselessly all day when attached to a train is equal to an increase of $\frac{1}{250}$ of the working expenses of a five-mile line, or $\frac{1}{4}$ per cent. of the profits; but one car and engine run unnecessarily all day causes an increase of [illegible] in the working expenses, or 5 per cent. on the profits.

fuel and oil; and the wear and tear of the machines, if carefully driven, should be precisely the same. All the conductors' receipts should also be almost of equal amount, and thus, by comparison, systematic dishonesty or neglect can be instantly detected. In addition, all the *employés* generally, having each in turn precisely the same duration of duty, be it night or day, early or late, and under almost identical conditions, no individual complaints can arise—a matter of vital importance on a large staff. In Paris, on Sundays, we ran 350 trains, on Mondays and Thursdays 300 trains, and on the other days about 250 trains, and yet every unit in the system averaged the same amount of work. Had we acted on the usual system, we should either have run 500 trains more in the week than were necessary, or been forced to employ extra hands on Sundays, &c., whose driving could not be depended upon.

The bell punch and uniform fares is the best control I have yet seen; but even that system requires public assistance to make it work satisfactorily. The French plan is absurdly complicated, and requires so large a staff as to eat up the profits.

Public.

All the public ask for is, quick through traffic, low fares, and a strictly observed unvarying time-table. They do object to the system of reduced mid-day omnibus speeds, whose rate of progress cannot be calculated from morning or evening experience.

Correspondence also is a public necessity, but too little understood in this country to be said to be a demand. By the establishment of suitable shelters, to the installation of which the public have as much right as cabmen, and of a miniature clearing-house for settling accounts, a traveller could take a through ticket from one end of town to the other by the first public conveyance available, and change vehicles *en route*, if by so doing his journey might be more rapidly or more conveniently performed.

Note.—In America this is done, to a limited extent, by the horn disc system. In Paris it is universal and obligatory, but the administration is too complex.

This public facility would, like all others, insure its own reward, by increasing the number of travellers, and reducing the dead weight represented by the enormous amount of empty seats constantly met with (except at certain hours) in 'bus, rail, tram, or steam boat. The inconvenience attendant on morning and evening pressure could also be by its means diminished, as by taking perhaps but a slightly more circuitous route, and changing once; a passenger disappointed of a place on the direct route could, in lieu of waiting about in the street, say as long as 20 minutes, get at least a step onwards to a more central spot, where more routes to his home were available.

Without venturing to criticise the systems of others, since I have one of my own, I merely describe such points of their systems as I can cordially endorse.

Colonel Beaumont, M.P., our gallant chairman (in a private pamphlet), very truly pointed out that a steam tram-engine is obliged, both in steam capacity and in weight, to be used of the maximum type which starting on the stiffest gradient exacts; and that, consequently, we daily see a 20 h.p. engine called upon to do duty which three horses could perform, and which, on a level, the engine-driver and stoker could almost undertake unaided.

The above discrepancy and waste of power Col. Beaumont attributes to the fuel being used, so to speak, locomotively; and, certainly, the mere horse power required, if generated in a fixed engine, could be procured with about 80 per cent. less fuel. Col. Beaumont, therefore, compresses air, and converts it into horse-power at about one-fifth the cost of steam; but, as in expanding the air again he loses about 70 per cent. of the power stored, the actual gain is not more than 10 per cent. He, however, maintains, and with great reason, that his is the only system which can work properly in a combined car, and that, as against a detached engine, his economy in dead weight will give him an advantage of quite 25 per cent.

Lamme's American fireless engine, besides the fatal inconvenience from loss by radiation, which renders every stoppage killing, is not economical in storing the power. The pressure in the fixed boiler cannot be fully communicated to the machine, the loss in transmission alone being 30 per cent.

Note.—The reasons of this are:—1. That the two boilers can never be of equal temperatures, and therefore attain equal pressures. 2. The air in the connection pipe is prejudicial.

Todd, of Leith, seems to treat the question of exhaust in a very masterly manner, but I have no personal experience of his invention.

Rowan, of Copenhagen, is the father of the combined car type; he has lately, however, gone in for a detached engine, the merits of which can be judged from the cartoon, showing an engine built built by Messrs. Kitson, of Leeds. He claims for the former all the well-known advantages on a bad road of the bogie—of getting on the line easily again, also by means of steering the bogie—a strong brake power, saving of dead weight, and a fan blast which does duty as an air-condenser.

Brown, of Winterthur, whose latest engine I had the opportunity of examining in Paris, has certainly produced a superior article. The machinery is raised five feet above the rail level, and the driving power transmitted by vertical levers and coupling and connecting rods. The levers being always in opposite directions, no counter-weights are required. His improved valve gear works very well, and with very little wear; its cut-off &c., is perfect, and eccentrics are not used.

Hughes, of Loughborough, takes a prominent place, because he has shown he can do good work at a moderate figure, while his engines have been running 15 hours daily, a most severe test. His weak point, like everyone else's, has been condensation, which has now been perfected, but details of this I am not at liberty to give.

The following statistics of the Vale of Clyde tramways show that he worked at 5·61d. per mile. Coke costing 24s. per ton, as against 48s. in Paris, and his engine requiring one man in lieu of two. The coke consumption was 8 lb. per mile.

Expenses for Six Days, or 1,800 Miles.

	£	s.	d.
Eight drivers at £1 7s.	10	16	0
„ overtime 15 hours ..	0	8	4
Two cleaners at £1 2s. 6d.	2	5	0
Waterman and coke carrier	1	5	0
Lamp cleaner (boy)	0	10	0
Coke, 6½ tons at 24s.	7	16	0
Oil, suet, and waste	2	0	0
Water, 63,660 gallons at 4d.	1	1	9
Salaries of manager, timekeeper, and office expenses	5	0	0
	31	2	1

Repairs.

	£	s.	d.
Leading fitter	1	12	0
Three fitters at 30s.	4	10	0
Smith, job work..	0	10	0
Carpenter, „	0	5	0
Materials, 12s. per engine	3	0	0
	9	17	0

	£	s.	d.
Running expenses	31	12	1
Repairs	9	17	0
Interest and sinking fund, say 20 per cent. on £5,000	0	13	1
1,800 miles ÷	42	2	1 = 5·61d.

Note.—Thus the cost of fuel plays a very important part in steam traction, it being mainly responsible for the disparity between working expenses in London and Paris. From experiments carefully carried out during the past six months, I am in a position to burn soft bituminous coal in the usual fire-box of a tram engine, not only without showing a particle of smoke, but, in addition, reducing the carbonic oxide almost to *nil.* We all know how destructive coke is to the plates when quick combustion is necessary; nor do the fumes it produces entitle it to pass muster for a street locomotive, simply because it makes no visible sign.

Messrs. Merryweather, the well-known fire-engine makers, have had more engines running than any other maker, having turned out about fifty. The earlier makes, however, were far too small, and required such constant attention as to have been provocative of many collisions, owing to the driver having multifarious duties to perform, which interfered with a sharp look out. In Paris no condensing or speed-checking apparatus were required by the authorities, so they were not supplied. Their Cassell engines were far superior, and have, it is said, been eminently successful.

Fox, Walker, and Co., though being last in the field, have profited by all the experience gained by 15 months' constant work in Paris. They are supplying the French Traction Companies of Paris and Rouen, and their engines for workmanship, economical working, and skilfully-met conditions leave little to be desired.

Mr. Perren's combined car possesses some points worthy of note. The steering is perfect, and the entrances are at the ends of the car. He distributes the load by using two boilers, one at either end, one active and one passive; the active one being always in advance for the time being, an arrangement requiring but one attendant, and no reversing stations. He uses a hand starter to overcome the extra difficulty in starting inherent to a combined car. Adhesion 60 per cent. of total weight.

In conclusion, the object of my paper will be achieved if my hearers are convinced that the question is absolutely a novel one, demanding original treatment from its birth; and that imitation, though considered flattering and never out of place as regards individuals, is often singularly so with regard to engineering questions.

DISCUSSION.

The Chairman said he had read few papers which contained more matter for discussion, and at the present time the discussion of this matter was very important. Last year a Committee of the House of Commons considered the question, and presented a report to Parliament, the result of which was that the Government introduced a Bill for the legislation of the application of mechanical power to tramways. That Bill was withdrawn on account of some notices of opposition, and it had not been re-introduced this year; his own impression being that no engine had been found which satisfactorily fulfilled the requirements laid down by the committee. That being so, it was a matter of great importance that it should be considered whether those requirements were reasonable or not, as proved by the results of any practical trial, either abroad or at home. He would not go into the details of the general requirements laid down, but they were of rather an arduous character to fulfil. The opinions of witnesses who gave evidence before the committee were unanimous, however, that the requirements of the committee were not more than mechanical skill and ingenuity could achieve. He was bound to confess, however, that when he read this paper he thought it contained a variety of requirements which would draw largely on the ingenuity of the mechanical engineer; and he thought they were far beyond the ideas of the committee. If it should turn out that an engine, to take the place of horses on tramways, must be made to fulfil all the requirements laid down, it would be very difficult, indeed, to find such a one. For instance, it was suggested that the diameter of the wheels should be regulated with a view to preventing the engine running too quickly, and this was a principle he could not at all agree with; also that crank axles were not right, but he did not quite understand how a tram engine was to be made unless the driving axle had a crank, particularly coupled with the statement that no outside connecting rods were to be allowed. It was said that 25 per cent. of the whole work done by the horses was spent in stopping the car; but, without going into details, he could not accept that, as he did not think it was anything like so much. Again it was stated the brakes had been used on a rising incline, to help the horses; but he did not understand how a brake could assist horses to go up hill. Again, it was laid down—which was important—that ten or twelve hours' running was sufficient for a steam-engine, and he quite believed that ten or twelve hours' running on the road represented a sufficient amount for a steam-engine and driver to do; but if that really were the case, it only showed that there were many difficulties in the way of the application of steam-engines to take the place of horses, which, perhaps, the committee had failed to recognise; and he hoped that such a discussion would take place as would assist the deliberations of the committee, if the subject were again brought before it.

Mr. Hale thought it would not at all be beyond the scope of engineers to produce an engine to answer all the requirements mentioned. He had no doubt that steam tramways would, at some future time, be adopted in London, but he hoped they would not be introduced into the best thoroughfares. He did not believe they would have the effect of frightening the horses.

Mr. Haddan stated, in reply to the Chairman, that

crank axles broke so often, that outside cylinders were preferable. With regard to brakes going up hill, he had no doubt that, if you were to try to go up an ice hill with a carriage and pair, you would not succeed; but, if you tried to go up a macadamised road, however rough, you could do so. Yet no one could say that the traction on ice was not easier than that on a macadamised road. Putting the brake on prevented the tendency to run back, which, on ice, would overcome all the pulling in the world. All he could say was, that, if you went to the places mentioned, you could see it done every day.

Mr. Ingram said they had had opposition in that room before now to improvements, and no doubt they would have to the end of the chapter. Some rather uncomplimentary remarks were made at the beginning of the paper upon mechanical engineers, who were spoken of as tradesmen, and Mr. Haddan seemed to think that they ought to consult civil engineers more than they did, but what is a civil engineer? You would find that almost every one that had anything to do with gas, water, water-closets, bell-hanging, or anything connected with metal, styled himself a sanitary, hydraulic, or gas engineer; and there were many men who styled themselves C.E. who had no more connection with engineering than perhaps taking an order on commission for a few brass fittings or a ton of bolts and nuts. The reason why mechanical engineers paid so little attention to civil engineers was because they had themselves been able to make the improvements which civil engineers had not. It was not a civil engineer who introduced working locomotives on railways; and, coming to the present time, it was not a civil engineer who introduced the first practical steam-engine on tramways—but Mr. Merryweather; and so throughout, the whole development of engineering was due to mechanical engineers. With regard to the Paris tramways, any experience from them was not worth serious contemplation in England. In the first place the lines themselves were about as bad as tramway lines could be; and in the second place, there was something in the French nature so volatile and unsteady that a thoroughly good French driver was not to be obtained. Some statistics had been put before them as to what had been done on the Paris tramways, but it had been found that any faults alleged against the engineers must in a great measure be attributed to the radical defects in the lines or the men who had to work them; and to assist them with control or management more elaborate than complete. With regard to the first engines run there—the small one of Mr. Merryweather—they were kept at light weight by special instructions. It was found, however, that it was not necessary they should be so light, and they were now made stronger. There was no comparison between a tramway engine and a locomotive. The latter had certain fixed work to do, started at a given point, and had so much time allotted to it. But the tramway engine was no sooner started than it had to stop again, and so on. Consequently there was a series of startings and stoppings, all tending to act and re-act upon the machinery, which was not found in locomotive practice. The breaking of crank axles must in great measure be attributed to the eminently unsatisfactory way in which the Paris lines were originally laid. He did not know whether they had improved during the past month or two, but a few months ago they were laid as cheaply and badly as they could be. Allusion had been made to Mr. Rowan as the father of the combined engine, but that room was the last place where an injustice should be done to the memory of the late Mr. Grantham, who received the Society's gold medal for the combined engine and car, which he invented some time before Mr. Rowan took up the subject. With regard to Messrs. Fox and Walker's engines they had not yet run on the Paris lines, but he believed they would do so in a few days.

Mr. J. Scott Russell, F.R.S., said they must be all much obliged to Mr. Haddan for the information he had given from his practical experience, which was especially valuable at the present moment. He had seen the engines of Mr. Hughes in Scotland, and Messrs. Merryweather's elsewhere, and had always considered that there was great promise in them; and he had no doubt that if the mechanical engineers of this country really set about the task, they would be able to create the very engines that were wanted in a perfectly satisfactory manner. He knew well what the difficulties were from his own experience of engines, for he had had the same class of difficulties to grapple with. It was quite correct to say that much larger bearing surfaces were required in such engines than in locomotives, and many adjustments which were not there called for. He also agreed with Mr. Haddan as to the extreme weakness of crank axles generally, but, of course, with a little experience, they would learn how to make them strong enough. Still they would not be wise things to use where concussions were constantly taking place in every possible direction. The great question appeared to him to be this—and it was one for both mechanical and civil engineers, and all concerned in this subject—was the separate engine or the engine combined with the carriage, the better of the two? Having looked at this question very seriously, he thought there were circumstances as to exceptional gradients and other things, which in one instance would go in favour of the combined engine, and in different circumstance would go in favour of the detached. At present his impression was that a steam locomotive engine, both for economy and management of stock generally, should be a separate carriage, however it might be made to appear outside as though it were a part of the other carriage; and that on the other hand, where you determined on the combined system, you ought to abandon steam and take condensed air or some such motor as the propelling power. His opinion, therefore, was against applying the steam-engine in the car itself, and in favour of using it separately, and in favour also in certain circumstances where you could conveniently do it, of having stationary reservoirs of power at which you could fill the reservoirs of the carriage with condensed air and use it as an economical and convenient propelling power. It was obvious that a large carriage with a couple of boilers in it was, to say the least, not very nice company to travel in. It was quite easy, and would in many instances be economical, to have fixed stations, at which the power could be accumulated, to be put into the car when it arrived. The great thing to be done with the detached engine was to make it more durable, and the only way in which this could be done was to more perfectly detach the propelling power from the propelling axle, so that all the mechanism of the engine should be relieved of the shocks upon the wheel. In no engines he had yet seen had that been perfectly done; but until you thoroughly detached the boiler, engine, and the whole of the mechanism from the horrible concussions which were received in every direction by these tramway axles and wheels, you could not rival the beautiful mechanism of the horse, who danced about on his legs without any of the jolts that steam horses had constantly to endure. The subject was an endless one, but this paper would contribute very materially to assist all engineers in meeting the various difficulties which had been quoted; and he hoped the mechanical engineers of England would now devote their attention to this subject, and that the public would thoroughly take up the tramway question. It was the great supplement to the railway question, and his opinion was, that instead of extending railways by small branches all over the country, it was now desirable that from every railway station should proceed, in all directions, a well-organised system of tramways. Though he was very fond of steam-engines, he would rather see them applied, in the first instance, to long

lines of tramway, which ran out of town, as feeders to railways, than in the crowded streets of a city like London. He would advise engineers to keep their locomotives out of Cheapside for the present, and rather to apply them where they would form a great public convenience to many, and would inconvenience but very few.

Mr. Matthison thought one point which was alluded to in the paper was of great importance, and was worthy of a large share in the discussion. It was said that the grooved tram-rail was far too hastily adopted by the profession; but he thought the profession had had but little to do with the grooved rail, which had been forced upon them by the authorities. In the United States, where they had more scope, they did not use them. In the interest of people who rode in carriages, there was no doubt the grooved rail was good, but for the tramway company the flat rail was much preferable, and when the question of steam-engines came up it was of still more importance, because much of the difficulties of the steam-car had arisen from badly laid rails, which at the best had been made only for horse-cars. Therefore any discussion as to steam-cars was useless until the best form of tramway had been decided upon. In Paris, he gathered, there was a very bad road, but they were much worse in many foreign countries. The point mentioned by Mr. Scott Russell of detaching the mechanism of the engine from the jolting of the road had been very successfully accomplished by Messrs. Kitson, of Leeds. There the action of the steam-engine was applied to a central axle, from which the power was taken to the wheels, thus saving the gear from the jolts of the carriage.

Mr. Kincaid said Mr. Haddan had laid down certain hard and fast rules, which it would be difficult for civil engineers to follow in practice, because there was hardly a case which came under their notice in which they did not find very different circumstances. For instance, the grooved rail was an absolute necessity in crowded towns where there was much carriage traffic, but it was not so in America, where this kind of traffic was comparatively small. No doubt the grooved rail with a fillet gave much more work to the engine than one without, and in many of the future lines, to which Mr. Scott Russell had alluded, it need not be insisted on, and a modification of the ordinary railroad might be adopted on which the traffic could be carried much more easily. He did not quite follow the table of receipts and expenditure, and it seemed to him that the working expenses were put very low—much lower than he had seen worked out anywhere else. As a rule, the expenses were a great deal more than 50 per cent. of the receipts, and he was not aware that the Paris tramways were worked at so much smaller a per-centage. The only experience they had had of the control of the Board of Trade in this matter had been in Glasgow, and from the report just issued by General Hutchinson, he came to the conclusion that the Board had well considered the matter, and were working out the general ideas of the committee alluded to by the Chairman. It seemed to him that the Board was taking an interest in the mechanical working of tramways, and was making its rules elastic, so as on the one hand to encourage manufacturers to produce what was wanted, and on the other hand to meet the requirements of the public. He agreed with Mr. Scott Russell that steam power was not suitable for combined engines and carriages, and that in such cases it would be better to use some of the other mechanical powers which were brought before the committee, and which he hoped would soon be at work. But the makers of steam-engines were going ahead so fast, and, from the trials he had seen in various towns, were arriving so quickly at perfection, whilst the experience attained in Glasgow and in Paris was leading to such improvements, that he did not doubt that next year they would run the inventor's compressed air and other engines very close indeed. He did not quite catch Mr. Haddan's view as to wooden rails, but did not think there could be any improvement on the rails used here for street tramways, though there might be in the mode of laying them. You could not have a different permanent way for the portion of the road which was on a steep gradient to that on the level, and he thought the rail now in use was about the best that could be devised. With regard to the difficulty of starting cars on a gradient, he had seen many machines devised for utilising the brake power as a spring to start the car again, but they had all failed hitherto in practical application.

Mr. J. Stables had had some little to do with the construction of the steam-engine patented by Mr. Brunton for the combined car used on the Wantage branch line, the particulars of which were described some time ago in that room, and which answered very well. The requirements of the committee, to which reference had been made, were very difficult to meet, though some people seemed disposed to make light of them. They required the car to stop immediately, and not to exceed a certain rate per mile, and several patents had been taken out to effect this latter point mechanically.

The Chairman said this was not recommended by the committee.

Mr. Stables said it was quite plain the report of the committee, if adopted, would place some difficulties in the way of construction, and he believed that this was the reason that the matter had not been more attended to by mechanical engineers, because they felt sure that some time must elapse before the engines would be required. There were many obstacles in the way of making a steam tram-car which should compete with horses, and stand the wear and tear of the road, and the dust, which was one of the greatest difficulties, and led to the necessity for making the engine as simple as possible. The public required a car which made no noise or smoke, and which could be stopped at any moment, to run upon a rail level with the street, and not to interfere in any way with carriage wheels. In New York the rails stood above the surface, and were almost as strong as those of a railway, and engineers had no difficulty in making engines which would run well upon them. The present rails required a very light engine to run upon them, thus it was found that the resistance was much greater than was anticipated, and therefore the cylinder area had to be made larger and the machines heavier. The cylinders in Messrs. Fox, Walker, and Co.'s engines were placed high up above the boiler, but unless they were in the centre of the engine there would be great oscillation, especially if there were two cylinders. He would suggest the cylinder ought to be in the line of pull and thrust so as not to interfere with the springs. Again, the axles and bearings should be made like the old mail-coach axles, with leather washers and oil boxes, and every part should be well covered and protected from dust, which was the great cause of repairs being needed. He hoped that steam tramways would be adopted, but thought the public were not yet ready for them, as it would be impossible to have them in every respect competing with omnibuses.

Mr. Rowan (Copenhagen) said it was quite true that the late Mr. Grantham made a combined car before he did, though he had previously taken out a patent. He might venture to give the result of his experience, because it was gathered from different sources abroad, and he had no interest or prejudice in favour of one maker more than another; he simply wished to get the best engine and the best system. Although he was not entitled in any way to be called the father of the combined car system, he was quite prepared to take the responsibility of it. The trials he had made since he

had ridden on Mr. Grantham's had convinced him more and more that the combined car would carry the day over the detached engine, and he could but regard the latter as a make-shift, though it was necessary at first, as so many companies had large rolling stocks, which they wanted to utilise. Without entering into the question of whether compressed air or steam was the best, he thought that whatever engine was best for the one would he decidedly the best for the other. There was a new field now open to the mechanical engineer, viz., to make a light engine. No one had tried in connection with railways to make a light locomotive, because there you must have weight to drive the engine, but in the combined car, if you could make an engine sufficiently powerful which weighed only 100 lbs., you could take it up any gradient, because half the weight of the load would always be on the driving wheel. He believed that if mechanical engineers had their attention directed to this point they could make engines strong and solid, and yet infinitely lighter than 5½ or 6 tons. Mr. Haddan laid great stress on the point that the engine and car combined would necessitate the engine going to the repairing shop and the car with it, but that was by no means the case with a car of the type he had been experimenting with, and he had seen the results of over a thousand miles run, under the direction of the Prussian Government. The engine could be detached from the car in two or three minutes, and any engine could be used with any car, although you got the full advantage of using the weight of the load to go up hills; and he laid great stress on that fact, because if you wanted to make cheap new lines to serve the railroads, you must expect to encounter sharp curves and steep gradients. He believed Messrs. Kitson's engine was the best which had yet heen devised, being much lighter, but with great power, having 28-in. cylinders, with a 15-in. stroke. They also had the advantage of being entirely boxed in from mud and dirt, and every part was under the driver's eye and control, and he could clean up while waiting and stopping. Still, he hoped before long, they would see an improvement even upon that.

Mr. Wildy wished to make a remark with reference to the statement that all attempts yet made to store up the momentum of the car when stopping, in order to use it when starting again, had failed. Last year there were several demonstrations on the lines of the London Tramways Company, in the Camberwell-road, of an apparatus invented by Mr. Phillips, which was perfectly successful, and at the present moment it was in thorough working order, though not applied to a car.

Mr. Haddan, in reply to what had been advanced, said Mr. Ingram had corroborated in the most striking manner what he had said about manufacturers. They did not require to be told what was wanted. The business of the civil engineer, he had always understood, when abroad at any rate, was to find out what was wanted, not the way of doing it. He might make the greatest mistakes mechanically, because that was not his province; it was merely to say such and such conditions ought to be fulfilled, leaving it entirely to the manufacturer to fulfil them as he thought proper. He had had nothing to do in laying down the Paris tramways, and if they were badly laid it did not affect him; but they were infinitely better laid than those in London, on which Mr. Merryweather tried his engines. Mr. Kincaid did not think anything better than the grooved rail could be found. He had only mentioned the wooden rail because the patent was not completed; but he thought all would agree that if they could run on a wooden pavement without expending more power than on the present grooved rail, it would be infinitely better for the carriage-riding public. On referring to the tables, it would be found that in case of horse traffic the expenses were in one case 50 per cent., and in another 70 per cent.; it was only in the case of steam that they were so much lower. Messrs. Harding and Co. only received 35 per cent. of the receipts, which covered everything, and left a profit of 90 per cent., so that it was clear that an expenditure of 50 or 60 per cent. in the case of steam was highly exaggerated. A remark had been made about the rules laid down being like the last straw on the camel's back; but it would be found, on examination, that each rule had at least a triple object. There might be one which appeared to suit the mechanical engineer, but on looking closer it would be found to suit the public also, and, looking still closer, to suit the civil engineer as well; they were all laid down, not to create obstacles, but to remove them. He might also say that his remarks were not intended in any way to the prejudice of Mr. Merryweather, or of the engines of his in Paris. Perhaps the only reason Mr. Merryweather objected to listen to anybody's advice was that those engines, which were found too light. were made strictly to order. As to the crank axles breaking, any other engines would have done the same, the jerks in the road being enough to smash anything. All he could say was that all the defects were made good, and no one could do more.

The Chairman, in proposing a vote of thanks to Mr. Haddan, said he did not think an outside cylinder would get over the difficulty of crank axles, because if you connected the leading and driving wheels it must be by means of a crank axle, so that, whether the cylinder were inside or outside, you must have a crank axle, unless you adopted the system of Messrs. Kitson. Mr. Scott Russell had endorsed what he believed was the correct principle, in laying down that if you had steam you must have a separate engine, because the inconveniences of steam were such that you could not have a steam-engine side by side with the passengers. Consequently, if you were obliged to have steam, you must have a separate engine. His name had been mentioned in the paper in connection with an air engine, and one of the advantages of that system was that it got over the difficulty, inherent in steam, of combining the engine and car together. It would not be in good taste for him to go farther into that question, but he might express a hope that, on some future occasion, he might have an opportunity of reading a paper, and explaining, not what he was going to do, but what he had done in that direction; and he believed there was every probability of such an engine occupying, with success, the field alluded to by Mr. Scott Russell. With regard to the limitation of speed, there was a great deal of evidence brought before the committee, to the effect that some limitation was desirable, and he quite coincided in the view that it was extremely desirable to have some means by which you could limit the speed on tramways, but when the committee came to consider the great difficulties there were in the way of providing any mechanical and self-acting regulator, they dismissed it as being quite impracticable. He believed the only plan would be to pull up the driver when he ran too quickly. There was this difficulty in connection with a regulator —it not only pulled you up if you went too fast, but if you wanted to go a little faster to get out of the way you could not do so, and, consequently, the very arrangement intended as a safety might become a matter of danger. Mr. Rowan, who had had a great deal of experience in these matters, especially in connection with combined engines and cars, had stated quite correctly, from his point of view, that it was desirable to get a light engine; but he would appeal to any mechanical gentleman whether a very light engine was not all but a mechanical impossibility. He had seen an engine used for torpedoes with a weight of something like 40 lbs., and yet indicating 40 horse power. That was a wonderfully light engine, but for any practical purpose except torpedoes it was useless, because the life of such an engine would be perhaps 40 days. The real thing you wanted to lighten was not the engine, but the boiler, which it was very difficult to do, because if you had a very light boiler, the steam space and water

space became so small that you would require a fireman to be almost on the top of the boiler regulating it continually, so that the difficulty in regard to a light engine lay really in the boiler. Heat and power were simply convertible terms. If you could devise some way by which a pound of coal could be flashed into mechanical energy in the state of steam at once without the intervention of a large boiler, you would have accomplished a thing which would be of enormous advantage, and would very much facilitate the application of mechanical power to tramways. He had not seen the report of the Board of Trade with reference to the trials made at the Vale of Clyde, but no doubt it would be well worth perusing. He felt nearly sure that what the Government and the House was waiting for before they dealt with this question was some engine that would fulfil not what it ought to do, but what it was supposed to do. As far as he had been able to learn from conversation with Mr. Haddan, the tramways in Paris did everything they ought not to do except paying, which he was bound to say, was a very great deal, and much better per-centage than the horses, and he was quite sure that the engines run in Paris would never be tolerated in England. In the first place, all the arrangements for condensing steam had been put on one side. In the next place, the stopping places at each end were more like railway stations than public squares; and, in the next, the steam from the engines was always blowing about, whether from the blast the man had to put on owing to the tubes getting sooty, and consequently unable to raise the steam required, or to the joints of the cylinder getting leaky. At any rate, you could not say that the provision required in this country, that there should be no escape of steam, had been complied with. Under these circumstances, it appeared to him that what mechanical engineers had to attend to was the absolute production of an engine which would fulfil the requirements laid down by the committee, and which would not run only two or three days together when committees and engineers come to see it, but should bear the test of continual working, and should have earned its money and come to the end of its six months, and paid its working expenses. He had no doubt that if anyone could produce such an engine, the difficulties which the Legislature at present threw in the way of introducing mechanical power on tramways would disappear at once, but until this was done there would be great difficulty in getting the question practically dealt with in the House of Commons. When that was overcome, it would be a great stride towards the extension of the power of locomotion in this country—namely, the extension of tramways. Railways formed the main arteries of communication, but it remained for tramways to complete the communication with villages and other places which could not otherwise be reached.

The vote of thanks was passed unanimously, and the meeting then separated.

Mr. D. K. Clarke writes as follows: —

The very first condition for the economical working of tramways is, that the way should be firm, uniform, and perfectly flat. A first-rate rolling surface is of prime importance, that the tear and wear of cars may be minimised, and also the tractional resistance.

The next condition is the abandonment of horse power for traction, and the adoption of mechanical power. Whatever the form of mechanical power to be ultimately adopted, it is evident that at present steam power is the only power that need be employed. The cost for horse power amounts to from 50 to 60 per cent. of the gross receipts, and it averages 6½d. per mile run by cars. For steam power, it has been established by experience that the work of traction can be done by a consumption of 8 lbs. of coke per mile run; and this datum affords a safe and ready means of estimating the cost for repair and renewal of steam tram-engines, by reference to the cost for railway engines, and the fuel they consume. The average quantity of fuel consumed on railways amounts to about 32 lbs. per train-mile, and the cost for repair and renewal is 3½d. per train-mile. It is proper to estimate the cost for repair of tram-engines in the ratio of the fuel consumed per mile; and it would amount to $3{\cdot}5\text{d.} \times \frac{4}{32} = 0{\cdot}875\text{d.}$ per mile run. Say in round numbers, 1d. per mile for repair and removal.

The annexed analysis and estimate of expenses with horse power and with steam power, clearly points to the comparative economy to be effected by the employment of steam power:—

Tramways.

Capital cost of 130½ miles of street tramway (mostly double), £18,707 per mile.

Receipts, 33 per cent. of capital; 12 companies, 137 street miles, 16d. per mile run.

Expenditure.	Per cent. of receipts.	Per mile run.
Horse power	55	6½d.
Drivers and poleshifters	9	1d.
Traffic	17	2d., nearly.
Principal items	81	9½d.
Repair of cars and way; general contingent	19	2¼d.
	100	11¾d.

Say, total expenditure, 1s., or 75 per cent. of receipts; 16d. per mile run.

	Per mile run.
Engine power—coke (8 lbs. per mile run), oil, &c.	1d.
Repair and renewal	1d.
Wages of driver and stoker	2d.
	4d.

Saving against horse power, 3½d. per mile run; or, about 30 per cent. of the receipts, equivalent to a dividend of 6½ per cent. on the capital.

MISCELLANEOUS.

WATER SUPPLY.

Mr. G. J. Symons, in a paper read before the Institution of Surveyors in Feb., 1877, says:—"Every inch of rain gives 22,623 gallons of water per acre, or 14½ million gallons per square mile. This is really the fact which forms the basis of all calculations respecting water-supply, whether it be a large town or a single house. . . . . . Without entering into the full details, it may be well to state the rough rule which (rightly or wrongly the author does not here stay to discuss) has been frequently acted upon with reference to large schemes of water-supply. Take, for example, an ordinary Yorkshire moor, with a rainfall averaging 40 inches, and a total loss, from evaporation and percolation, of 12 inches. The calculation has often been made in the following form:—

	Inches.
Mean rainfall	40·0
Deduct, for floods and unstorable water	6·6 or ⅙th.
	33·4
Deduct, for evaporation and percolation	12·0
Available rainfall	21·4

"This, according to Parliamentary usage, would be

allotted, two-thirds to the party making the reservoirs, and one-third to the stream.

I believe that this division of the available water has no other basis than usage, and it appears to me that a rule ignoring, on the one hand, the very various nature and cost of the works, and, on the other, the varying extent to which different streams are or can be utilised, is far too rough for universal employment, as is at present the case, even works costing a million or more sterling being apportioned by this rough-and-ready rule.

Another respect in which the existing mode of private Bill legislation is creating rights of very doubtful public expediency, is the granting of absolute water rights over large tracts of land to the first body, whether company or corporation, which asks for them, and comes to terms with the landowners and with the millowners on the stream. Surely, the wise and proper course would be to stop the present scramble, in which the wealthy and the venturesome have it all their own way; to have a careful survey made of the still unseized lands available for gravitation waterworks, and then (subject to all proper payments by the parties taking them) let them be appropriated to the various communities in conformity with their proximity and with their requirements.

GENERAL NOTES.

Technical Education.—The Council of the City of London College have arranged to supplement their science classes with a course of six popular lectures, bearing upon the application of science to the wants of daily life among the industrial classes. The course will commence on Saturday, 2nd March, and will be illustrated by numerous experiments in mechanics, physics, and chemistry. These lectures have been prepared by Thomas Twining, Esq., formerly one of the vice-presidents of the Society of Arts, and well known for his endeavours to promote the study of science by working men. The office of reader will he undertaken by Mr. Henry Adams, professor of engineering, and that of demonstration by Mr. H. Maiden, science teacher. The admission fee has been fixed at one shilling for the course of six lectures, and it is hoped that the attendance of working men, with their wives and families, will be such as to prove that the Council have acted wisely in thus keeping the cost within the means of all. Mr. Twining has promised to give prizes to the value of £2 among every ten candidates who offer themselves for examination upon the topics of the lectures.

The Birkbeck Institute.—This, the first English Mechanics' Institute, has fairly outgrown its original quarters, and a new building has become necessary, if the work which has been so long and so well carried on within its walls is to be efficiently continued. From the last report of its Educational Council we learn that there are now 3,304 students of the institution, and that several classes are so full that the issue of tickets is stopped. Lord Northbrook, who has recently taken some interest in the work of the institution, has suggested that a new building should be erected, and the Lord Mayor has consented to hold a meeting at the Mansion-house for the inauguration of a movement with that intention. The old institute grew up, over 50 years ago, along with and promoted by the *Mechanics' Magazine*, and it would hardly befit *Iron* to mention the proposed extension of the Birkbeck Institution as a mere item of local news. Sixty-five thousand students have passed through the courses of instruction afforded at Southampton-buildings, where, under a modest name, a true evening college has existed for more than half a century. Many of these students have since become eminent in literature, science, and manufactures; many others have made their mark in commerce and the City; one, at least, has attained the dignity of Lord Mayor. It is, therefore, speceially becoming in the present head of the Corporation to give the civic sanction to a movement of so deserving a nature, especially at a time when the Companies are considering how they can best encourage technical education. Possibly as good a way as any of beginning this work in earnest would be for the City to build a home for its technical university and instal the Birkbeck Institute as its evening tenant. Subsequent arrangements for instruction in the daytime might be easily added or developed, and London be before instead of behind all the rest of the world in the possession of a college uniting theoretical and practical teaching.—*Iron.*

Importation of Meat.—According to Messrs. Tallerman's circular the total of preserved meat importations in 1877 amounted to 23,536 tons, valued at £1,438,909, as against 14,043 tons in 1876, valued at £884,273, being an increase of 9,493 tons, valued at £554,636. The importations from the Australian Colonies during the year have been 200,420 cases, as against 155,677 cases in the previous year, the several colonies contributing as follows:—New South Wales, 1877, 86,105 cases, 1876, 60,338 cases; Victoria, 1877, 68,249 cases, 1876, 65,415 cases; Queensland, 1877, 22,902 cases, 1876, 22,447 casss; New Zealand, 1877, 22,400 cases, 1876, 6,803 cases; South Australia, 1877, 764 cases, 1876, 674 cases. The fresh meat importations by refrigerative processes were—1877, beef, 23,266 tons, valued at £1,266,280; mutton, 6,763 tons, valued at 403,962; total, 30,029 tons, valued at £1,670,242; 1876, beef, 8,536 tons, valued at £462,947; mutton, 4,770 tons, valued at £285,451; total, 13,306 tons, valued at £748,398, being an increase for the year of 16,723 tons, valued at £921,844. Of the year's imports, 5,250 tons were received at the London Meat Market. These returns of our imports are much below the statements of exports from America, which are published as about 46,800 tons.

NOTICES.

THE LIBRARY.

The following works have been presented to the Library:—

Design and Work: a Home and Shop Companion. Vols. 1, 2, and 3. (London: G. Purkess, 1876-7.) Presented by the Editor.

Purification of Water-carried Sewage, data for the Guidance of Corporations, Local Boards of Health, and Sanitary Authorities, by Henry Robinson and J. C. Melliss. (London: Smith, Elder and Co., 1877.) Presented by J. C. Melliss,

The Clergy Directory and Parish Guide for 1878. (London: Thomas Bosworth, 1878.) Presented by the Publishers.

Boiler and Factory Chimneys, their Draught Power and Stability. with a Chapter on Lightning Conductors, by Robert Wilson. (London: Crosby, Lockwood and Co., 1877.) Presented by the Publishers.

The following Pamphlets have been presented:—

Metropolitan Pauperism (printed for private circulation). Presented by F. Edwards.

A Mile of Railway in the United Kingdom, by F. T. Haggard. (London: Effingham Wilson, 1869.)

A Few Remarks and Facts *apropos* of the Indian Famine and of the Remedies Proposed, by Sir Arthur Cotton. (Bath: The *Herald* office.) Presented by the Author.

The Crown and the Cabinet: Five Letters on the Biography of the Prince Consort, by "Verax." (Manchester: Alexander Ireland and Co., 1878.)

The Woolwich System of Rifled Ordnance; a contribution to the History of its Invention, by its Inventor, W. F. Padwick. (London: C. F. Hodgson and Sons, 1878.)

The following have been presented by their various Committees:—

Birmingham Free Libraries. Catalogue of the Reference Department, by J. D. Mullins, Chief Librarian (Birmingham, 1869.) Catalogue of the Shakespeare Memorial Library, by J. D. Mullins; 1st

part and sections 1 and 2 of the 2nd part (Birmingham, 1872-76).

Norwich Free Library. Catalogue of the Lending and Reference Department (Norwich, 1877).

Royal Dublin Society (now National Library of Ireland). Catalogue of the Library, 1731-1839, and Supplement 1839-1849, by J. F. Jones; Supplement 1849-1859, by E. R. P. Colles (Dublin, 1860), and Catalogue of Books added from June, 1858, to September, 1873.

Liverpool Free Public Library. Catalogue of the Reference Department to 1870, by Samuel Higgins (Liverpool, 1872), and Supplemental Catalogues for 1871-75 (Liverpool, 1873-76).

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at eight o'clock. The following arrangements have been made:—

February 27.—"The Past, the Present, and the Future of the River Thames." By J. B. Redman, Esq. The Right Hon. Lord Otho Fitzgerald will preside.

March 6.—"An Electric Lamp-lighting System." By St. George Lane Fox, Esq.

March 13.—"Phonograph, or Talking Machine." By Hervey Edmunds, Esq., Jun.

March 20.—"Emery and Corundum Wheels for Grinding and Surfacing Metals and other Materials." By A. H. Bateman, Esq., F.C.S.

March 27.—"State Aid to Music at Home and Abroad." By Alan S. Cole, Esq.

April 3.—"Our Wealth in Relation to the Imports and Exports of the Country," by E. Seyd, Esq. W. Hawes, Esq., F.G.S., will preside.

Indian Section.

Friday evenings at eight o'clock. The following arrangements have been made:—

February 22.—"Irrigation Regarded as a Preventive of Indian Famine." By W. T. Thornton, Esq., C.B. Colonel H. Yule, C.B., R.E., will preside.

March 15.—"The Colonisation of Hill Districts in India." By Lieut.-General McMurdo, C.B. Edwin Chadwick, Esq., C.B., will preside.

March 29.—"The Depreciation of the Value of Silver, with Especial Reference to the Exchange between India and England, and Suggestions for a Remedy." By Col. J. Smith, R.E., F.R.S.

May 3.—"On the Telegraph Routes between England and India." By Major Bateman-Champain, R.E.

Chemical Section.

Thursday evenings at eight o'clock. The following arrangements have been made:—

February 28.—"The Chemistry of Infection, or the Germ Theory of Disease from a Chemical point of View." By C. T. Kingzett, Esq., F.C.S.

Cantor Lectures.

Monday Evenings, at Eight o'clock. Second Course, on "The Application of Photography to the Production of Printing Surfaces and Pictures in Pigment." By Thomas Bolas, Esq., F.C.S.

Lecture II.—February 25th.

Phototypic, or raised printing blocks, by swelled gelatine process, zinc etching, and other methods.

Lecture III.—March 4th.

Line engraving on metal plates.

Lecture IV.—March 11th.

Printing of half-tone subjects from metal. Application of Asser's process. Talbot's Photo-engraving. Woodbury's methods for engraving and printing.

Lecture V.—March 18th.

Collotypic printing.

Lecture VI.—March 25th.

Other methods of producing photographs in pigment. Dusting-on method. Autotype printing.

Third Course, on "Some Researches on Putrefactive Changes, and their Results in relation to the Preservation of Animal Substances." By B.W. Richardson, Esq., M.D., F.R.S. April 8, 15; May 6, 13, 20, 27.

MEETINGS FOR THE ENSUING WEEK.

Mon.....**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Thomas Bolas, "The Application of Photography to the Production of Printing Surfaces and Pictures in Pigment." (Lecture II.)
Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. C. N. Bazalgette, "The County Administration Bill, now before Parliament."
Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m.
Institute of Actuaries, The Quadrangle, King's College, W.C., 7 p.m. Mr. T. B. Sprague, "How does an Increased Mortality affect Policy Values?"
Medical, 11, Chandos-street, W., 8.30 p.m.
London Institution, Finsbury-circus, E.C., 5 p.m. Rev. W. H. Dallinger, "Researches bearing on the Theory of Spontaneous Generation."

Tues....Royal Institution, Albemarle-street, W., 3 p.m. Prof. Garrod, "The Protoplasmic Theory of Life and its Bearing on Physiology." (Lecture VI.)
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. Harrison Aydon, "Liquid Fuels."
Anthropological Institute, 4, St. Martin's-place, W.C., 8 p.m. 1. Mr. W. S. C. Boscawen, "The Primitive Culture of Babylonia." 2. Mr. Hyde Clarke, Exhibition of a Weapon from New Zealand.
Royal Colonial, 15, Strand, W.C., 8 p.m. Dr. J. Forbes Watson, "The Character of the Colonial and Indian Trade of England contrasted with her Foreign Trade."

Wed....**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr. J. B. Redman, "The Past, the Present, and the Future of the River Thames."
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m. Sir Patrick Colquhoun, "Historical Outlines of the Leading Religions of the World."

Thur....**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Chemical Section.) Mr. C. T. Kingzett, "The Chemistry of Infection, or the Germ Theory of Disease from a Chemical point of view."
Royal, Burlington House, W., 8½ p.m.
Antiquaries, Burlington House, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 7 p.m. Mr. W. Crookes, "The Radiometer."
Royal Institution, Albermarle-street, W., 3 p.m. Prof. Dewar, "The Chemistry of the Organic World." (Lecture VI.)
Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.
Philosophical Club, Willis's-rooms, St. James's, S.W. 6½ p.m.

Fri.......Royal United Service Institution, Whitehall-yard, S.W. Mr. H. J. Butter, "The Working of Heavy Guns by Manual, Hydraulic, and Steam Machinery."
Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Dr. Richard Liebreich, "The Deterioration of Oil Paintings."
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8 p.m. Annual Meeting.
Geologists' Association, University College, W.C., 8 p.m.
Philological, University College, W.C., 8 p.m. Paper, by Prof. Cassal.
Archæological Institution, 16, New Bulington-street, W., 4 p.m.

Sat.......Physical Science Schools, South Kensington, S.W., 3 p.m. Mr. W. H Preece, "The Phonograph."
Royal Institution, Albermarle-street, W., 3 p.m. Mr. Bosworth Smith, "Carthage and the Carthaginians." (Lecture VI.)

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,319. Vol. XXVI.

FRIDAY, MARCH 1, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

The second lecture of the second course, on "The Application of Photography to the Production of Printing Surfaces and Pictures in Pigment," by Mr. THOMAS BOLAS, F.C.S., was delivered on Monday evening last, the 25th inst. These lectures will be published in the *Journal* during the recess.

NATIONAL TRAINING SCHOOL FOR MUSIC.

The competition for the vacant Sim Scholarship was held at the National Training School for Music, on Monday, the 25th February. The examiners were Dr. Stainer (the Deputy Principal of the School), Mr. Ernst Pauer, and M. Alberto Visetti. There were five candidates. The scholarship was awarded to Miss Mulholland, aged 16 years.

BLOWPIPE APPARATUS.

In May last, a prize of £10, which was placed at the disposition of the Council by Col. A. A. Croll, was offered by the Society of Arts, with the Society's Silver Medal, for the best set of Blowpipe apparatus which should be sold retail for one guinea. The conditions were that the apparatus should, at least, contain blowpipe, blowpipe lamp or candle, spirit lamp, charcoal or charcoal pastilles and holder, platinum wire, glass tubes closed at one end (matrasses), open glass tubes, platinum-tipped forceps, magnet, hammer and anvil, and four re-agents, viz., borax, microcosmic salt, carbonate of soda, and nitrate of cobalt. These instruments and re-agents, together with any others which might be thought desirable, were to be packed in a box. It was assumed to be understood that the above list of apparatus, &c., was only intended to include such as are absolutely indispensable, and it was expected that the set would contain additional instruments and re-agents, the selection of which was left to the competitors.

Special attention was called to the following points:—1. Solidity of construction; 2. Compactness and portability; 3. Facilities for packing and unpacking; 4. Number of useful instruments and re-agents, in addition to those mentioned.

The apparatus for competition were to be sent to the Society's House on or before 1st August, 1877, and it was stipulated that the successful competitor should guarantee that a proper supply of the apparatuses should always be kept on hand, for sale in England.

The following Committee was appointed to consider the award of the prize:—Major-Gen. F. C. Cotton, C.S.I. (Chairman of the Council), Mr. F. A. Abel, C.B., F.R.S., Dr. C. Le Neve Foster, Captain Douglas Galton, C.B., F.R.S., Admiral Sir Erasmus Ommanney, C.B., F.R.S., Mr. E. C. Tufnell, and Mr. Warington Smyth, F.R.S.

In response to the offer, eleven sets of apparatus were sent in. These were all subjected to careful trials by Dr. C. Le Neve Foster, H.M. Inspector of Metalliferous Mines, and on his report the Committee determined that, though many of the sets showed great merit and considerable advance beyond what was previously obtainable for a guinea, no one of them showed such excellence as to justify an award to it of the prize offered. It was, therefore, resolved that a fresh competition should be opened among those who had already sent in, and a letter was addressed to each of the competitors, pointing out what the Committee considered to be the deficiencies in his set, and inviting him to send in a set of apparatus modified in accordance with those views. The date for the new competition was fixed for December 31st.

In response to this second offer, seven sets of apparatus were sent in, all of which the Committee consider to have shown decided features of merit. These were treated in the same way as the former sets, and the Committee determined to recommend that the prize should be awarded to Messrs. Letcher, of Camborne and St. Day, Cornwall. They also recommended that a second prize, consisting of a bronze medal, should be awarded to Herr Osterland, of Freiberg, in consideration of the great excellence of his apparatus, though they consider that the packing arrangements are hardly of a nature to stand rough usage.

The report of the Committee was received and adopted at the meeting of the Council on Monday last.

INDIAN SECTION.

Friday, February 22nd, 1878; Colonel H. Yule, C.B., R.E., in the chair.

The Paper read was—

IRRIGATION REGARDED AS A PREVENTIVE OF INDIAN FAMINES.

By W. T. Thornton, Esq., C.B.

It has been observed by a recent Edinburgh reviewer that "the question of the preventive measures which may be adopted in order to diminish the evil effects of those recurrent seasons of drought which we must expect to be by no means unfrequent in the future, is one so large, that to discuss it exhaustively would be to write a treatise on the art of Government in India." It is only one, and by no means the most important, branch of this great subject, which is now about to be brought forward, but even that one I cannot venture to introduce without apologising beforehand for the inadequate treatment which it must necessarily receive at my hands. Properly to discuss irrigation —even under the single aspect to which I shall confine myself—to do justice to the extent, without disguising the limits, of its utility as a palliative of Indian famine; to specify both the indispensable conditions of success, and the obstacles which, in certain situations, might necessitate partial or even total failure, would require a minute acquaintance with details obtainable only by personal observation to which I have no pretension, and my deficiency in which would, but for one consideration, have deterred me from accepting the task which, in spite of all misgivings, I have undertaken. But a really honest and truth-loving inquirer, however incompetent himself to shed fresh light on the darkness he is investigating, may yet indirectly cause new light to be brought upon it. Very likely I shall presently be caught both mistaking facts and drawing mistaken inferences; but among those present here are many well able to correct my blunders, and they will, I trust, accept it as their duty to compensate for the poverty of my text by the richness of their comments.

These few words of preface will be perceived to imply that I am not myself disposed to credit irrigation with being anything like a specific for the evil for which it is so generally prescribed; but those who differ from me most widely on that point may perhaps be somewhat propitiated by my proceeding to observe that if irrigation could be shown to possess all the virtue which they ascribe to it, the most serious objection—that of costliness—to its indefinite extension would in great measure disappear. Heartily sympathetic as Mr. Bright's extra-parliamentary audiences usually are, some of his hearers were probably a good deal startled when, not long ago, he insisted on the expediency or rather quasi-necessity of forthwith devoting no less than thirty millions sterling to the immediate construction of new irrigation works in India. Many, too, of those present at the great public meetings which Sir Arthur Cotton has recently addressed, if not equally surprised, were perhaps equally unconvinced, when they heard him enumerate several works which would certainly cost at least the amount mentioned by Mr. Bright, but which he nevertheless insisted should be undertaken without delay. For my own part, however, I am quite prepared to admit that were irrigation really as efficacious as it is believed to be by its most ardent advocates, and provided also that the outlay about to be mentioned would suffice for the object in view, to expend not thirty millions merely, but twice or thrice that amount in providing complete means of irrigation for the entire length and breadth of India, would be not extravagance, but economy.

This admission is made quite irrespectively of the vexed question whether Indian irrigation works have or have not as yet been profitable speculations in a pecuniary sense. In a paper which I had the honour of reading before this Society two years ago, I did indeed endeavour to show that the works actually in existence, far from deserving to be stigmatised, as they so frequently are, as financial failures, are really, when regarded in the aggregate, a decided financial success; and subsequent inquiry and consideration have only tended to confirm me in that opinion. Even though no one of the existing irrigation works had hitherto made any positive return upon its cost, there might still be solid ground for arguing that the construction of more works of the same character would be the reverse of extravagance.

Money cannot be said to be wasted, however small the money's worth obtained from any particular application of it, if, unless applied in that particular manner, it must needs have been expended in some other from which return of any money's worth at all would have been out of the question. Now, the Indian Government has of late accepted a new and most onerous obligation—that of securing its subjects, to the best of its ability, from destruction by famine—from which it will never be released while India continues to be a British dependency, and the character of its administration to be consequently permeated by English ideas and feelings. But what does this newly-assumed responsibility imply? Within little more than one single, and that the latest, decade, there have been four great, and three terrible, famines. Within little more than the previous sixty years there had been ten others, whereof three or four, at least, are not less dismally memorable. During the last four years, the Government has disbursed fourteen millions of hard cash in famine relief, and is supposed to have lost three or four millions more of land revenue, which the destitution of famine-stricken cultivators compelled it to remit. During the last four years, then, it has, on an average, annually sacrificed for the relief of famine three-and-a-half millions sterling, which would evidently have been much better employed, provided such employment had been possible, in preventing that same famine.

The term "famine," morever, when used with reference to India, has a specially serious significance, commonly meaning that territories at least as large as Ireland, and very likely larger than Germany, are affected; while "dearth" or "scarcity" is the name applied to visitations on a smaller scale. I alluded just now to a list of fourteen famines

in different parts of India during the last three-quarters of a century, but from that list are omitted eight minor, but still widely devastating dearths, which affected extensive portions of the Bombay Presidency; about as many experienced in the Madras Presidency; and three or four in the North-West Provinces and the Punjaub. If we had corresponding information with regard to minor territorial divisions, the number of omissions might be greatly augmented. For instance, in some papers which I lately had occasion to consult for a quite different purpose, I find it stated that in Bundelcund, one of the North-Western Provinces, famine was experienced in 1830, 1834, and 1838, or three times in eight years; that of 1834 being so severe that one district was "denuded of nearly half its population," while in another, thirty-five villages were totally desolated, and in two others "seventy-two villages were laid waste and left without an inhabitant." Further, that in some parts of the province "one out of every four or five years is sure to be a failure." The same sort of thing might, I believe, be said of Bellary and other provinces. It is, in short, not improbable that scarcely a year has passed since we became masters of the greater part of India, in which in some quarter or other of that vast dominion, there has not been famine severe enough to impose on the local authorities the necessity, if not of expending large sums for the relief of the sufferers, yet, at least, of remitting large sums due to the exchequer, which the impoverished inhabitants were utterly unable to pay. This, too, was in the past, while as yet Indian famines were very generally looked upon as resulting from Divine interposition, with which it was as useless for man to attempt to cope as with earthquakes or hurricanes, and while, whatever the spasmodic efforts made to prevent people from dying of starvation, still thousands, nay hundreds of thousands, were allowed so to die on account of the apparent impossibility of saving them. Yet even then, in the short interval between 1860 and 1871, no less than £340,000 of land revenue were remitted in Bundelcund alone. What, then, is the prospect which the Government of India, with its newly-awakened sense of duty, has before it for the future? If there be any truth in the new scientific theory of decennial or undecennial cycles of increasing and diminishing sun-spots, accompanied by similarly periodical variations of rainfall, we cannot be sure that in every ten or eleven years there will not always be two or three tremendous droughts, which, unless guarded against, will eventuate in famines, each of them imposing upon Government a pecuniary burden, direct or indirect, of six, eight, or ten millions sterling; while, in every intervening year, minor, but still fearful, visitations of the same kind will absorb hundreds of thousands of pounds. Is there, then, any extravagance in asserting that, if natural causes be left to take their course, the Government is likely to be henceforward saddled with the equivalent of a poor's-rate averaging two millions sterling annually? But, in the present state of the Government's credit, two millions of yearly interest represent a capital of fifty millions, so that if prevention be better even than cure, and proportionately better still than mere alleviation of distress, fifty millions might be most advisably spent, within the briefest practicable space, in preventing famine by means of irrigation. Fifty millions, I say, even on the supposition that the irrigation works thereby provided would yield no direct pecuniary return to the investors, but no one supposes that they would make absolutely no return; and if, while the works actually in existence are yielding, on an average, seven per cent., the new ones which I am contemplating should pay only two per cent., the fifty millions might be prudently doubled, and a hundred millions employed in the manner alluded to. To me, then, I confess it seems clear that, provided their premises could be admitted, the most ardent of irrigational enthusiasts would have little difficulty in making out their case; that, even confining themselves to the narrowest and most sordid grounds, they could show it to be not extravagance but economy, to lay out as much as a hundred millions in the manner they propose, on condition only that thereby their object could be attained. For, irrespectively of the tremendous mortality, and of the prolonged suffering still worse than death that precedes death by starvation; and in addition to the immediate expenditure and losses incurred by Government, there is a destruction of property belonging to the people at large, which results in further and subsequent Governmental losses.

Turning again to the Bundelcund papers, to which I refer so particularly simply because equally minute information with respect to any other province happens not to have come in my way, I find more than one illustration of the slowness with which a territory once desolated by famine recovers—often, too, recovering only partially. "I found," says one officer, writing in 1868-9, "the poorer classes reduced to the lowest extremity, their cattle sold, their fields bare, and without other means of subsistence than was furnished by wild berries or by the few stunted plants that had not actually withered. The better classes were reduced to want and brought into debt. The total loss was computed at 85,335 head of cattle, or 20 per cent. of the whole stock of two districts; and of these, 20,000 were plough cattle, representing the power of cultivating 50,000 acres." In a third district, out of 233,000 cattle, about 95,000, or 41 per cent., died; while in a fourth, the destruction of human beings caused that of sheep and oxen to be overlooked. Cholera and malignant fever had followed in the track of famine, and, lingering after it had ceased, swept away more than 20,000 victims for 3,180 who had perished from actual hunger. In this last district, advances to the amount of £15,000 were made to the people; but, says our reporter, "The advances went to buy bread and preserve life; wells, consequently, have not been sunk; want of men and cattle stops tillage; 60 per cent. of the land revenue demands have been suspended." Then come a few figures—dry in themselves, but full of meaning for the financier—showing that the revenue suspended in one year, instead of being realised in succeeding years, is a nucleus round which subsequent accretions group themselves, forming, at last, an amount so hopelessly large that there is no alternative but to write the whole off to loss.

Thus much having been premised, and it having been admitted to the most uncompromising of irrigationists that, provided their premises were

unimpeachable, their extremest conclusions likewise might be demonstrable truths, let us proceed dispassionately to examine those premises; let us calmly and candidly inquire what good irrigation is capable of doing, and what are the necessary limits of its beneficence. Those limits will, I fear, be found to be much narrower than is generally supposed.

The public works which in India are classed as irrigational are of three kinds, inundation canals; canals, commonly, though not always correctly styled perennial; and tanks. Those of the first description, which are, I believe, confined to the Punjaub and Sind, are artificial cuts or adapted natural water courses, led off from the Indus or its affluents, and are dry during the winter, receiving water only when the rivers are in flood. The principle upon which the other two sorts of works are constructed has been concisely stated in a very able and interesting contribution to the November number of the "Nineteenth Century," by Colonel Chesney, whose words, however, few as they are, I must endeavour to make still fewer. Any tract of country through which a river flows must necessarily have a downward slope of greater or less rapidity. If then a dam or weir, or, to use the Indian terms, a bund, or anicut, be anywhere thrown across a river, a canal or canals led off from the reservoir formed in the rear of the dam, although starting with a surface level somewhat below that of the adjoining country will, if made with a smaller slope of bed than the general slope of the country, presently be raised to a height somewhat above that of the flanking country, and will thenceforward continue to be of greater height, so that with the aid of ramifying and gradually diminishing channels its water will be rendered available for irrigation by the mere force of gravitation. Moreover, when the supply of water brought from the first reservoir can go no further, having been sucked up by the thirsty ground on both sides of the canal, a second dam and a second reservoir with a second set of canals may be constructed lower down the river, and a third still lower, and so on, if need be, at proper intervals down almost to where the tidal influx makes the water brackish.

The principle of tank-construction is often identical with, and always similar to this. A reservoir, which, though termed a tank, is really an artificial lake, seldom, I fancy, smaller than the sheet of water generally met with in an English gentleman's park, and very frequently as large, or larger than Windermere or Ulleswater, is formed either by damming up the bed of a mountain torrent, or a valley which had previously given passage to the natural drainage of the neighbourhood, or by raising, even in comparatively level tracts, where the surface has a regular inclination, however slight, in one direction, a three-sided embankment, whereof the lowest side is of uniform height, while the other two sides gradually diminish in height, until they terminate at the level of the ground. The apparatus for distributing the water is the same in character for tanks as for bunded rivers, viz., a system of ramifying channels, although, of course, on a smaller scale. Where the contour of the country permits, several tanks follow each other in a connected series. The first embankment is thrown across a gorge high enough up to retain sufficient water for all the irrigable land lower down, and descending terraces are occupied by a succession of reservoirs, the higher feeding the lower from its surplus supply.

It would be waste of time to dilate on the utility of works of any of these classes in average years. Even where the aggregate rainfall of the year is most abundant it is still more or less irregular, and the climate is probably nowhere so continuously humid but that many days occur in which the farmer longs anxiously for rain which does not come, and when he would have abundant cause to bless the provident care that had placed artificial supplies of other water within his reach. But in seasons of drought such supplies are simply invaluable. Up to 1860 the Ganges Canal had been a byeword of reproach in the mouths of anti-irrigationists, but in that dreadful year, and again in 1868, when much of the North-West had become a temporary Sahara, the luxuriant oases created and maintained by the canal furnished food enough for the plentiful subsistence of a million of people who must otherwise have perished, or have been kept alive at the public expense. In the still more terrible year which has just ended, and when most of Southern India presented a picture the impression of whose harrowing details will never be obliterated from the minds of those who witnessed it, the deltas of the Godavery and Kistna, permeated as they are by artificial streams, and likewise the strips of land beside the till-then condemned canal of the Madras Irrigation Company, must have seemed Gardens of Eden to all who entered them from the adjoining Valley of the Shadow of Death. It is almost impossible, then, to over-rate the importance of such irrigation works as can be implicitly trusted to preserve their efficiency unimpaired in the severest trial; in other words, to continue in a condition to furnish the water of life when that water is most needed. But are there any such? If so, foremost amongst them must be those canals whose fountain heads are the Ganges, the Jumna, the Indus and its affluents. These mighty rivers are commonly regarded as taking their rise among the Himalayan glaciers, and as being as sure of constantly adequate supplies from the mountain snows in the hot season, as the snows themselves are sure to be then melted by the increased heat of the sun. I suspect, however, that this notion is, in part at least, a mistake. For, besides that the heat emitted by the sun at the same season, instead of being a constant, is an exceedingly variable quantity, and that, consequently, its influence on the snow must vary proportionately, the so-called Himalayan rivers do not, I believe, spring from the snowy region, but take their rise in a tract a good deal lower down, and are mainly dependent, not on the melted snow, but on the rain that falls within that tract. Now, though, in the driest years, this rain is almost everywhere a literal deluge, it is still a deluge not less inconstant than that of other similar localities, and every one understands how diminished pluvial discharge among the Mountains of the Moon can make seven years of famine alternate with seven years of plenty in the lower valley of the Nile. It is true that Indra, the Indian representative of the Greek Zeus, the gracious and beneficent God of the Atmosphere, never fails to lead a stately procession of summer

rain clouds from the Southern Ocean to the sub-Himalayan slopes, but the evil spirit, Vrita, is always, in some form or other, lying in wait for him, and not seldom intercepts or disperses great part of his train, permitting him to reach his destination with only a much diminished retinue. As a matter of fact, the maximum discharge at the head works of the Ganges and Jumna canals is often less by a fourth in one year than in another, and it cannot have been forgotten how greatly, and with what disastrous consequences, the usually soaking rainfall of upper Tirhoot was diminished in 1873. So, too, the inundations of the Indus, which are commonly confined to a narrow strip on either side the river, occasionally refresh the desert at a distance of a hundred miles. It is obvious then that even in Northern India not only is not irrigation capable of indefinite extension, but that if provision were made for the utmost extension possible in one year, immense tracts of ordinarily irrigated land might in extraordinarily deficient seasons, be left without a drop of water. But if the northern and most fortunately circumstanced rivers are liable to these vicissitudes, far greater must be the risks incurred by those of the Deccan, where there are no snowy mountains, nor indeed any eminences of more than 4,000 feet, and where what mountains there are intercept most of the moisture which they attract. The Godavery consequently, the Kistna and Cauvery, which rise eastward of the Western Ghauts, receiving as they do only fluctuating portions of the originally fluctuating mass of rain clouds which the Ghauts do not arrest, and depending in great measure on the rainfall of the territories drained by them on their onward course, vary exceedingly from year to year in maximum volume. The Godavery, for example, which when in flood has usually from seven to 12 feet of water running over its anicut or dam, never at any time last year had more than from two to three feet there. The Kistna rolled down in such a diminished volume, that the great irrigation works in the Masulipatam Delta were stinted in their supply; and the Cauvery, also, was affected, though in a less degree; while as for the numerous minor streams which have their sources still further to the east, and are absolutely dependent on the rainfall in their immediate vicinity, they generally dwindle to the merest threads in the dry season. The catchment basins of these minor rivers constitute in large measure the very tracts which the rivers might be rendered capable of occasionally watering, so that how much soever these latter might be utilised, the canals connected with them would be in great danger of being empty when most required to be full; and it is not too much to say that if so they might seriously aggravate instead of relieving whatever famine they failed to prevent. No doubt in ordinary seasons they would both vastly augment the productiveness and greatly promote the extension of cultivation, and thus allow of food being stored up and of wealth in other forms being accumulated, but it is probable that these results would be realised in only a moderate degree, if at all. It is much more probable, or rather it is absolutely certain, that in the present state of Indian human nature the growth of population would proceed nearly *pari-passu* with that of the means of subsistence, and that consequently in seasons of drought severe enough to dry up irrigation at its source, the sufferers from famine would simply be very much more numerous than before. And if canals cannot be relied upon in such junctures still less can tanks. Speaking of the Madras territories, Sir Richard Temple tells us that the failure of crops last year was most complete on lands which in ordinary seasons would have been styled wet by reason of their being irrigated. Look at any map of Southern India on a sufficiently large scale, and you will see large districts as thickly dotted with tanks as a colander is with holes. In Mysore, for instance, there are 37,000 of them; and here it may not be amiss to supplement what has already been said of tanks in general by some additional details respecting those of Mysore in particular. "Wherever there is a depression in the land an embankment is thrown across it with a waste-weir and a sluice. The water is held up above it, and below it a few acres are sown with rice or sugar-cane, and irrigated by means of the sluice. A few yards lower down the depression comes another tank, and again another, increasing in size as they go on till a series of tanks may consist of more than a hundred, all connected together; the overflow from the waste weir of each being the chief feeder of the one below it, and the stream that issues from the waste weir of the bottom one being a river. The tanks at the top of the series are mere ponds, those at the bottom are often small lakes, and the area irrigated by these is often very large." Now, of such tanks there are in Mysore, as I said just now, no less then 37,000, the "wet" or irrigated land being one-sixth of the whole cultivated area; and Madura and Chingleput are apparently equally well, and North Arcot still better provided. But it is clear that provision of this sort did little or nothing towards lightening the visitation of the last two years. As early as February last, Sir Richard Temple found that in two-thirds of Mysore nearly all the rain-fed tanks were dry. Of parts of Madura visited by him in the preceding month, he says:—"The tanks are all rain-fed, and they are dry, so no crops have been saved by tank water;" while in Chingleput, where more than one-half of the whole cultivation is technically termed "wet," he found that "what are usually splendid sheets of water had become scorched, dusty plains, or huge black patches, with cracked and fissured soil. The sluices, the distributing channels, the whole apparatus of irrigation lay useless." It was something if, here and there, the bed of a tank had retained some moisture long enough to allow of there being still a little withered herbage for the starving cattle to pick up.

Here it may, however, be urged, that what we have to deal with is the rainfall, not of single years, but of undecennial periods—that the quantity of rain falling in every eleven years may be regarded as a constant quantity, and that the problem before us is how to utilise the whole of that quantity. In considering this problem, I shall be careful to avoid laying excessive stress on the colossal proportions, and proportionately colossal costliness of the irrigation works indispensable for the suggested utilisation. I will, for the sake of argument, assume, though not without inviting attention to the boundless liberality of the as-

sumption, that every Indian river had been adequately bunded, and that where there were no rivers, reservoirs had in some other way been created of the utmost size and number desirable, insomuch that no drop of water ever fell upon the land, which, if capable of being turned to irrigable account, was permitted to reach the sea. Still, in order that water should anywhere be stored, it must first exist there; and there are in India vast breadths of country which never, in any single year, receive more rain than is required for that same year's service. The south-west monsoon, which invariably drenches the Concan with at least 100 inches, lets fall at Poonah, only 60 miles inland, not more on an average than 25 inches, and its central blasts are almost exhausted of moisture before they reach the heart of the Deccan, while the north-east monsoon, which usually deposits thirty inches in the neighbourhood of Madras, has generally lost all its moisture before it reaches the districts of Bellary and Hyderabad. Evidently districts like these, and the remark applies in a greater or less degree to much of the table land that occupies the entire space between the Eastern and Western Ghauts, and stretches northward as far as the Satpoora range, there is never any surplus rain which even Cyclopean embankments could render available for a season subsequent to that within which it has fallen. Although asserting this, I do not of course deny that, inasmuch as the average annual rainfall of all India is estimated at 110 inches, a wall of brass encircling the entire country might make the whole enclosed space alternate between a lake and a morass, but that, I take it, is not a consummation to be very devoutly wished for by the most ardent of aquatic zealots.

Nor is liability to partial or total deprivation of their indispensable supplies of water the sole drawback from the utility of irrigation works: another has been expressed with epigrammatic force and neatness, as the inability of water to run uphill. This objection may possibly admit of a more satisfactory reply than it has hitherto received, but if so, the reply ought to be given without further delay, for in the meantime the objection cannot but act as a stumbling block against the diffusion of advanced irrigational ideas. Neither from the banks of any river nor from the site of any tank does the ground decline on all sides with so uniform a slope but that its surface is broken by occasional undulations, and it is manifest that even in the Gangetic Doab, a land wave only a few feet in height will suffice to prevent any watery waves from penetrating to its rear. But Southern India, in general, consists, not of low lying plains, but of lofty table lands, averaging 1,500 feet above the sea's level, and rising in places to double that height, and the rivers which traverse it have their channels for the greater part of their course deep down below the surface, so that to throw anicuts across the Godavery or Kistna in order to irrigate the adjoining plateau at any points much higher up stream than Rajahmundry and Dowlaishweram, where anicuts have actually been placed, would be even more preposterous than with a similar view to bund up the Avon at Clifton, or the Rhine between St. Goar and Goarhausen. It is plain then that if irrigation works were multiplied to the very utmost extent possible, if every river, every torrent, every rivulet were bunded, and if tanks were constructed on every site on which water could be obtained to fill them, a very great part, infinitely the greater part, of India would still be left high and dry. Still, however, it may perhaps be said, there remains the resource of wells. But wells are already largely resorted to in many quarters. Coimbatore, for example, at the base of the Neilgherries, is said to contain 100,000 of them, sunk in many cases through hard rock to a depth of 80 or 90 feet, and capable in ordinary seasons of irrigating from one to four acres each. But in seasons so extraordinary as those which have lately been experienced, these wells, although they may not fail absolutely, do in great measure fail like everything else. When the correspondent of the *Times* visited Coimbatore he was told that the subsoil water which supplied them had sunk from eight to ten feet lower than it had ever before done within living memory.

I do not include among the objections to irrigation works the unwillingness of cultivators to pay for the water thereby provided for them, because I believe that that unwillingness might be obviated by suitable measures; among which, however, I am not disposed to reckon the compulsory exaction of water rates. Rather than adopt so extreme a course, I should prefer going to the opposite extreme, and allowing the cultivators to have the water for nothing for a year or two, in full assurance that having once discovered its value by experiment, they would thenceforward eagerly pay a fair price for it rather than go without it.

I shall not I trust, by reason of what I have been saying incur the very unjust suspicion of desiring to disparage irrigation. Most assuredly nothing has been further from my design than to assail a cause of which I have hitherto always shown myself a zealous partisan. *Defendi adolescens, non deseram senex:* I am not going to turn traitor in my old age. It is in precisely the same friendly spirit in which I have on former occasions vindicated what I believe to be the just claims of irrigation, that I now protest against what seems to me exaggeration of its pretensions—exaggeration than which nothing is more likely to bring it into contempt, by engendering expectations in regard to it, which, if acted upon, would inevitably end in bitter disappointment. But, while denying that even universal irrigation could be a specific for famine, I cordially admit that irrigation, very far short of universal, would be not only a most valuable palliative and remedial auxiliary, but would likewise serve as a partial preventive. For although, even if every single irrigable tract were adequately provided with irrigational apparatus, the greater part of the country would still lie outside the reach of irrigation, and would therefore continue as liable to drought as before, while a year might seldom pass without one or other even of the irrigable tracts being converted into a temporary desert, still, inasmuch as the most extended of Indian droughts is always local, the greater number of these latter tracts would escape. Now irrigation, besides allowing cultivation to spread widely over land which has previously lain waste, allows new and more eligible crops to be raised on land previously cultivated, and everywhere, moreover, in a ratio varying with the character of the soil, doubles, trebles, quadruples,

possibly even octuples crops of all kinds. Thus although there might still every year be somewhere or other within Indiam limits one or more dried up Canaans, for whose relief the Government would have to send to Egypt to buy corn, such Canaans would, on the other hand, be fewer and smaller, and there would, within the same limits, be many more Egypts than at present in which to buy it. By all means then let the Government do its part in diffusing irrigation to the very utmost extent to which it can judiciously do so. Let it not grudge the thirty, sixty, or whatever number of millions sterling the enterprise may require. Quite possibly, the outlay may amply repay itself, even though it only diminish the drain upon the exchequer without sending any money thither, but, provided it be conducted with tolerable judgment, it cannot fail to make considerable direct pecuniary returns, so that—always with the same proviso—it will be pretty sure to prove a good investment. But let it not be supposed that by acting in this way the Indian Government will be entering on some novel path. Here, having been for more than forty years a servant of the Indian Government, I cannot refrain from putting in a word on behalf of that much abused authority—abused on all sides, for all it has either done or left undone, but, in respect to public works, abused with especial vehemence and with especial inconsistency; for while one portion of the public joins with Mr. Bright and Sir Arthur Cotton in reproaching it for having spent so little on such works, another portion joins with my friend Mr. Fawcett in condemning it for having spent so much. On the present occasion, the charge of extravagance may be left unanswered, but to those who inveigh against the Indian Government's shortsighted and apathetic parsimony, I do not hesitate to reply that no other Government, ancient or modern, has, within an equal period, been nearly so lavish in respect to public works as it has been during the last twenty or thirty years; not that of Augustus, who found Rome brick and left it marble; not that of Louis XIV., who squandered such enormous sums upon palaces that he was afraid to look at the bills even after they had been paid, and had them burnt accordingly; not that of Napoleon III., who, to judge from the building which tourists found going on all over France during his reign, must have had a Baron Hausmann, not only in Paris, but in all considerable and in most inconsiderable towns. Nor will the comparison be less favourable if the nature as well as the quantity of work be considered. Some two hundred thousands or so of pounds have of late years been spent and are being spent in India on palaces, and some eight millions on barracks; but on railways, roads, and other means of communication, the Government has, since 1855, incurred an expense little if anything short of a hundred and twenty millions; and that it has not in the meantime been neglectful of irrigation a very few words will suffice to show. In 1864, Lord Lawrence, being at the time Viceroy of India, discussed with a Council, counting among its members Sir Charles Trevelyan, Sir Robert (now Lord) Napier, Sir Henry Maine, and Sir William Grey, the best means of extending irrigation, when one of the conclusions unanimously arrived at was expressed as follows:—"It will be a day of the greatest promise for the future well-being of India when the Government shall take the first decisive step towards the gradual but systematic introduction of irrigation works into every district now liable to occasional seasons of drought." The word chiefly to be noted here is "systematic," for already there had been a pretty considerable though spasmodic expenditure on canals from the Ganges, Cauvery, Godavery, and three or four other great rivers. The pace at which Governments ordinarily move, being dignified, is slow, and the first step towards which Lord Lawrence was looking in 1864 was not actually taken until 1869, when his Lordship, being still Viceroy, and the Duke of Argyll, Secretary of State for India, a programme was devised by the former and heartily concurred in by the latter, according to which thirty millions sterling of borrowed money, over and above the usual contributions from ordinary income, were to be applied to the construction of a number of specified irrigation works. Of this thirty millions, nearly one-third has actually been expended in accordance with the plan, and Government is virtually committed to the other two-thirds for completion of their programme. This first programme too was not intended to be a final one. Both Lord Lawrence and the Duke of Argyll, and their successors in office were, and are perfectly aware, that, when it has been worked out, another will have to be framed, and another probably after that, involving altogether an outlay quite as large as the profusest of their critics has dreamt of; so that Mr. Bright, while so indignantly upbrading the Indian Government for lethargy, was in reality unconsciously plagiarising an idea of theirs, and upbraiding them for not having begun a work in which they had already made great progress. It can only have been imperfect acquaintance with the facts that prevented him from resorting to blessing instead of malediction, and from cordially wishing them God-speed in a career in which their advance had to so great an extent forestalled his aspirations. Perhaps, however, the rate of progress at which the Government plans are being realised may be less satisfactory than the plans themselves; but surely this is a point on which the Government must be left to judge for itself. Lord Lawrence's mantle has descended on a series of worthy successors, and the Indian Government whatever it may once have done, no longer now requires jogging. It is notoriously living up to the very verge of its income, notoriously spending on public works the very utmost penny it can afford, and to be able to afford more, it must impose new taxes; but a population impoverished by three tremendous famines within fifteen years is not precisely the most fitting subject for additional taxation. Besides, if the British public think the Indian Government too dilatory in this matter, that public has the remedy in its own hands. It would, of course, not urge the Government to invest more lavishly in irrigation works, except in full assurance of faith that such investment would prove adequately remunerative; but, if so, why does it not take advantage of Governmental remissness, and embark largely in irrigation schemes—of course, without asking for guarantees —for why should it require security against risks which it is confident do not exist? and even, let me add, without that last relic of the guarantee

system, the gratuitous grant of land. It should be grateful to, not angry with, the Government for leaving so profitable a field open to private enterprise, instead of greedily monopolising it. For my own part, indeed, it would be with anything but unqualified satisfaction that I should see British capital taking this course. Not, however, from fear that it might not reap the expected reward. Such fears, however well founded, would, I confess, cause me little distress. Great Britain habitually overflows with wealth, which is sent abroad because there is no room at home for its profitable employment, and, as every one knows, much of the wealth sent on foreign errands fails to find the profit which it seeks. It would be matter for congratulation, therefore, if this, instead of being wasted on Turkish ironclads, or embezzled by Honduras bubblemongers, were applied to the canalisation of India, even though the people of India got all, and British capitalists none, of the benefits of such application. My apprehensions, however, refer, not to the possible failure, but to the probable success of the supposed investments. I do not at all like the idea of the large addition, which, in that case, remittance to England of the profits on the invested capital, would make to the already far too large tribute paid by India to England. Neither is it to be forgotten that what would be impressed upon the Indian agents of British investors as their first and highest duty would be that of securing the largest possible dividends for their principals, and that consequently in their dealings with the ryots they would be unlikely to exhibit much of that forbearance for which the servants of the Indian Government are distinguished, and the absence of which would not be forgiven by their masters. Above all if, as I myself have no doubt, large profits may with good management be derived from Indian irrigation, I want to see those profits appropriated in the first instance by the Indian Government as trustees for the Indian people, who are so sorely in need of every possible addition to their scanty national resources, not sent to this country to swell the enormous wealth with which British capitalists are already surfeited.

The Government, moreover, may promote irrigation not merely by the construction of costly works, but also, and perhaps even more effectually, by indirect means, and without any expense to itself. Of the large perennial canals actually in existence, all were made either by the British Government or by preceding rulers; but the inundation canals, so numerous in the Punjab and Sind, which give to much of the land bordering the Indus something of the appearance of the valley of the Nile, although sometimes 80 or 70 miles long, are for the most part merely shallow trenches, varying in width from 10 to 100 feet, and many of them owe their origin to individual or associated landholders. So likewise do most of the tanks, and probably all the wells, which, in tracts remote from any considerable river take the place of canals. Under British domination, and the operation of new agrarian arrangements, the old spirit of communal association has sadly decayed, but even where most nearly extinct it is still dormant, and it might everywhere be easily revived and persuaded to take an irrigational direction. When, between forty and fifty years ago, Colonels Hall and Dixon, being placed successively in charge of the newly annexed wilds of Mairwara, speedily brought the wilderness under agricultural subjection, and converted the previously unruly inhabitants into an orderly community, one of the first steps taken by them was to induce the ryots to bund up torrents, build tanks, and dig wells. Uuder the auspices of Sir Henry Ramsay, the present Commissioner of Kumaon, a canal has been led off from the river Sardah, whereby wide stretches of dense and deadly jungle at the foot of the hills have been cleared, peopled, and covered with luxuriant crops. The cost of this work, about £20,000, was undertaken by the landholders of the neighbourhood, who, having at first been aided by an advance of the amount required, had the other day already repaid most, and have probably by this time repaid the whole of it. In 1874, Captain Grey, Deputy-Commissioner, and Mr. H. C. Fanshawe, Assistant Commissioner at Ferozepore, persuaded several of the village communities within their jurisdiction to construct 250 miles of water courses, whereby about 200,000 acres which previously yielded crops in exceptional years only, are now secured against all seasons not so exceptional as almost to dry up the Sutlej. The whole work was finished within the twelvemonth, and though it involved the excavation of more than 44 million cubic feet of earth, and the embankment of nearly four million feet, the money outlay was little more than £2,000, for almost all the labour was given gratuitously by the villagers, who marched down in the morning with pick and basket, in troops 300 or 400 strong, to the sound of drum music, and returned home in the evening in equally noisy triumph.

These examples may suffice to show how widely beneficial personal influence might become, how much a popular Commissioner or Collector might almost anywhere do, and, under the impulse which a hint from the supreme authority would impart, would seldom fail to do. It may here be worth while to remark that, although not to be implicitly relied on in the hour of need, wells are much more trustworthy than rain-fed tanks. A few months ago, when these were everywhere dry, the wells very generally retained some water, though far less than the smallest quantity they had ever before held, and it was chiefly by their aid that some little vegetation was here and there kept alive, even in the most afflicted districts. It has been observed that in Dharwar "wells seldom fail from a single season of deficient rain, and that many will last for two, or even nearly three, years of drought, without drying up, or even having their supply much diminished." It would, then, apparently be well to encourage the multiplication of wells, even in the vicinity of tanks, and it would also seem that the digging of wells deserves a foremost place among the relief works which the local or central authorities are, in seasons of famine, under the necessity of instituting. No doubt, too, engineering science could suggest modes of well-sinking much more expeditious, and much less clumsy and costly than those which have from time immemorial been in use in India.

It is much to be regretted that irrigation works and railways should frequently, and on very high authority, have been represented as antagonistic,

instead of being, as they really are, naturally and mutually dependent allies—mutually dependent more especially in their bearing upon famine. Clearly, it is not a whit more essential that abundance of food should be produced, than that there should be means of carrying it where it is wanted. We might as well talk of antagonism between the cart load and the cart. Famine has never yet been so severe or universal, but that within Indian limits there has been food enough to feed the entire population, but it is above all things railways that have permitted of their being fed with it. But for the superabundance of the North brought down by rail to the South during the last two years, there could have been no relief works or relief camps; instead of magazines of imported human food there would have been myriads of dead human bodies to serve as food for dogs and vultures. It has indeed been contended that canals of irrigation may subserve both production and carriage, but this is an opinion which is open to something more than doubt. The combination of navigation with irrigation has long been a favourite idea of Anglo-Indian engineers, but there have as yet been but three instances of its satisfactory realisation, and those three are all of a peculiar character. The Godavery, Kistna, and Mahanuddy are all exceptionally large rivers, and the anicuts thrown across them are very far down stream, at the apices indeed of their respective deltas. The quantity of water stored in rear of the anicuts is thus more than ordinarily large, while the length of country between them and the sea is more than ordinarily small, so that to supply the distributary canals with water enough for the use of the adjacent fields, and yet to keep them full enough to be navigated by flat-bottomed boats, is a comparatively easy problem. Moreover, it is only the fringe of the India peninsula, or rather some small fragments of the fringe which are capable of being thus benefited. In the interior of the country, the circumstances are very different. Even on the longest, widest, and deepest canal in the whole world—the one supplied by the mighty Ganges—it has been found exceedingly difficult to maintain navigation; and what navigation there is decreases visibly as time goes on. On the Baree Doab Canal, fed by one of the main affluents of the Indus, the attempt to keep up navigation is, I have heard, about to be abandoned after several years' trial. But if the combination in question be so nearly hopeless in such comparatively favourable circumstances, what chance is there for it on canals far inland, which, obtaining a much smaller quantity of water from minor rivers, must, in order to be of any material use for purposes of transport, remain of undiminished volume for a course of one or more hundreds of miles under a tropical sun and through thirsty land that is everywhere tapping them. My friends and colleagues of the Madras Irrigation Company's board of directors are now about to try the experiment. Having already spent between £300,000 and £400,000 on locks in order to make their canal navigable, they are now arranging to spend some £80,000 more in providing boats and other appliances requisite for putting its navigability to the proof. Most heartily do I wish them success, but I cannot add that I also hope it, for hope implies expectation, and it will be to me a very agreeable surprise if their canal, after giving off water enough to irrigate the 150,000 acres, which in technical phrase it is said to command, will have water enough left to float down to market the crops which it has contributed to raise. Besides, in seasons of famine, expedition is a prime necessity. Even though India had possessed the completest net-work of canals, still if the grain from Bengal the North-West, and Punjab, by which so many millions in the south were last year fed, could have been sent down only by water-carriage, myriads of the starving wretches, for whom it was destined, must have perished, while the food sent to save them was still on its way. It should be recollected too that—to judge from the example of the Madras Irrigation Company's Canal—in order to make an irrigation canal navigable, its cost must be increased by something like a fourth.

I fear I have already detained this meeting too long, although as many persons present must be aware, I have only lightly skimmed the surface of my subject. If, then, I venture to claim attention for a minute or two more, it will be only in order to show how merely fragmentary my whole discourse has been. It has been almost confined to consideration of the best means of preventing water that might be beneficially diverted to the land from being carried uselessly by rivers to the sea, but no allusion has been made to the at least equal importance of providing beforehand for detention of part of that water on the land, and for preventing it from ever reaching the rivers. Three-quarters of a century ago, immense tracts in Southern India were overspread with jungle, and the slopes of both Eastern and Western Ghauts were almost universally forest clad, but most of the level woodland has since then been cleared for cultivation, and the hills have been stripped of their trees in order to suppy fuel for railways. Contrary to what might have been expected, there is no evidence to show that the actual rainfall has decreased in consequence, but it is notorious that another and scarcely smaller evil has resulted. Formerly the water showered down from the skies was partially protected from evaporation by sheltering trees; its flow over the surface was mechanically resisted by standing trunks and fallen stumps, and by jungle-grass, mosses, fungi, and decaying leaves; it had time to be absorbed by the upper layer of vegetable mould, and, after this was saturated, to sink into the mineral earth below, and to fill whatever cavities there might be still lower down, thereby converting them into reservoirs calculated to ensure the permanence of natural springs. What remained proceeded to replenish the tanks it met with on its passage; and not till all this was done did the residue find its way to the rivers, and that at a comparatively tardy pace. Now, however, as a rule, the rivers are in violent flood for about as many days as they used to be for weeks in moderate flood. No sooner is there a copious fall of rain, than a perfect deluge scours the fields, washes off whatever slight dressing of manure or other fertilising elements there may be on the surface, often sweeps away the growing crops, or covers them inches deep with sand, breaches entire chains of tanks, and finally reaches the rivers in torrents, which destroy or seriously damage massive railway bridges and still more massy anicuts. Wholly to obviate

these gigantic mischiefs might, perhaps, be impossible, except by expedients more mischievous still, for no one would wish to see the corn and rice fields that have taken the place of jungles, replaced in turn by the jungles they have supplanted. Still, art and nature combined might easily, one would think, re-clothe with wood hills which nature once clothed without help from art; there is all over India abundance of waste land on which Government might with profit to itself form plantations; and kindly counsel on the part of revenue and other authorities might everywhere persuade village communities to surround their fields with hedge-rows, and to convert district roads into shady avenues. This, however, is a topic on which I cannot now dwell, though I could not altogether forbear from referring to it with the view of suggesting that, however desirable it be to extend irrigation to the utmost, there may, nevertheless, be arrangements of a different kind that may go far towards doing away with the necessity for irrigation.* Another matter which must be left almost untouched is the neglect or misuse of an agricultural agent, only second in value to water, viz., manure; as to which I must content myself with saying that some excellent advice in regard to it may be found in a recent pamphlet on "Public Health," by my friend Mr. Edwin Chadwick, who, to my knowledge, had previously given, and, I fear I may add, had thrown away, similar advice with especial reference to the sewage of Cawnpore. Yet another unnoticed matter must be the constitutional helplessness of the mass of the Indian peasantry, which prevents their making the best of things in bad times; a helplessness proved by the comparatively flourishing appearance, even in the worst seasons, of village lands occupied by exceptionally energetic communities in the very heart of famine stricken districts. Neither can I stop to speak of the desirability of lightening the bondage in which the peasantry are so generally held by money lenders, and under the pressure of which it is impossible that their energies can be more than languidly exerted. Still less can I venture to repeat what I have already said in print,† and what I confess, were this the proper time and place, I should much wish to say again, as to the modifications which Indian land tenure almost everywhere imperatively demands, and as to the stimulus to industry and thrift which the general adoption of a tenure akin to that of the Punjaub would impart; and I must be silent also as to the beneficial changes which diffusion of English ideas, by means of extended English education, could not fail to effect in the Indian character. For, as I began by intimating, to treat of all the subjects closely connected with the one selected for this evening's consideration, would be to investigate the whole field of Indian economics, and I am well aware how much I must have already tried the patience of the Society, and how incumbent it is upon me in concluding to tender to them my best thanks for having borne with me so long.

* An interesting article on "Floods and Famines in India," will be found in Macmillan's Magazine for January last.

† See "Indian Public Works." Macmillan, 1875, chapters 6 and 7. Although very unwilling to seem to recommend my own writings, I should, I own, be glad if I could persuade any person interested in India to read these two chapters of my little book.

DISCUSSION.

Sir Arthur Cotton said this was nothing less than a question whether we were to leave India in its present dreadful state, or rise up like men and Englishmen and come to the rescue; whether we should find 50 excuses for letting men die by millions, where we could obviate it, or whether we should rise up like men and do something. The last time he had the honour of meeting Mr. Thornton he was rather disappointed, for he hoped to have had a little fight with him, but he then found he was entirely with him; for he said most distinctly that it was utterly false to say that the irrigation works had not paid, but on the contrary, that they were yielding full interest, and on the average double the ordinary Government interest. Such a statement coming from a gentleman connected with the India-office was extremely important. He had now given up two or three very very important points which, up to the present time, had been argued. For instance, as to the refusal of the water by the natives. This had been made a general complaint, that irrigation works could not be constructed without a certainty almost of the water being refused; but this was simply an exceptional case. Mr. Thornton, however, fell back upon other points, which, if correct, were sufficient to entirely stop our efforts, and let another million or two people die by famine. One point was the quantity of water; but it was extremely absurd for anybody to throw a doubt on the quantity of water in India. The average annual fall there was at least four feet, and in the worst years about three feet, whilst 12 inches would secure a crop, if properly regulated, on every acre. It was therefore quite certain that in the worst years, on an average, upwards of three times as much rain fell as would secure an ample crop on every acre, and it must be remembered that there were 500,000,000 of acres in India. Therefore in the worst year which ever occurred enough rain fell to provide food for ten times the population of India. It was stated that the Godavery last year was so low that it only ran three feet over the annicut. He did not know whether it was correct, but supposing it were so, the anicut was 4,000 yards long, so that the quantity discharged over it, supposing it was three feet, would be 1,200,000,000 cubic yards per day, or sufficient to secure a crop on a million acres of ground, and therefore the water which went over the anicut in one day was sufficient to secure the lives of three millions of people during the famine, and this at a time when it was said there was such a dreadful failure. Ten days of that supply would provide a crop for the whole thirty millions who were in danger last year. The next point was that water would not run up hill! How could he answer such things as that? He was ashamed to have to speak of such things. Did not the water fall on the tops of the mountain as well as on the coast? Was it not found on every level? One of the reservoirs made by the Government was 7,000 ft. above the level of the sea; another 2,000 ft.; and another 1,600 ft.; and there were 10,000 tanks between 2,000 ft. and 3,000 ft. above the sea level. One of the finest projects proposed to the Government, and examined 25 years ago, was 1,600 ft. above the level of the sea. In that tract of which Mr. Thornton had spoken, Bellary, where no water was to be had, there was the never-failing Toombudra river, which was always filled by the south-west monsoon, and carried to the sea millions of cubic yards of water every hour: and yet it was said they could not water the land through which it passed. Then it was said that anicuts could be built on the Kistna and Godavery at the head of the Delta, but not higher; but an anicut had actually been built by the Madras Irrigation Company, in imitation of scores of old native works, 900 feet above the sea. Next, it was said they could not use the water for navigation. He had a letter with him, not from a rash, enthusiastic, hydraulic engineer, but from a sober, intelligent, talented, railway engineer, the first in India, in which he stated the fact

that the Eastern Bengal Railway had been in the field for 12 or 13 years, and had literally acquired only one-tenth of the traffic. This was an unanswerable argument in favour of a canal by the side of it, He went on to say that the present Eastern traffic was about 1,900,000 tons, and was rapidly increasing. And a toll of $1\frac{1}{4}$ rupees per ton on this alone would yield a return sufficient to pay all expenses, and 11 per cent. on the capital outlay; and the western traffic would probably double this. He also said, that, assuming the actual cost of transit to be eight annas per ton, the total cost of goods would be 1 rupee 12 annas, on which there would be a saving of £840,000 a year on the eastern traffic alone, in comparison with the present transit by boat, steamer, and railway. That was a saving of three-quarters of a million on one single line of 130 miles out of Calcutta, where there was already a railway and bad river navigation. This came from Mr. Leslie, the head railway engineer in India, and it only confirmed what he had said thirty years ago, that the railways could not carry the quantity nor at the price that India absolutely required. These views were also confirmed by Sir Richard Temple, who said that "although some portion of the traffic was carried by railway, the main part followed the water highway between Eastern Bengal and Calcutta, though it had to go several hundred miles farther than if there was a straight route by water. The obvious remedy would be to construct a canal for navigation across the country from Eastern Bengal to Calcutta." Yet he had been held up before the House of Commons as the rashest and wildest of men. That did not signify; but it was a tremendous question whether Calcutta was to lose three millions a year on that comparatively short distance for want of proper canals; and what was good for 130 miles was good for the next 1,000. It was equally applicable to every main line suitable for canal navigation in India, and if Calcutta were losing at this moment three millions a year on its eastern and western and south-western lines for want of canals, what was the whole of India losing throughout all its main lines, and what had it lost during the 20 years since he pressed on the Government the construction of that very canal. This was how the revenues of India were thrown away, and then people wondered that they could not make both ends meet. With respect to the refusal of the water by the ryots, the only instance in the whole of the Madras Presidency was on the Toombuddra works, and that being so, anyone would say there must be some mistake there. If one railway in England was continually having accidents, whilst others did not, people would say there must be something that matter with that railway. So in this case, there must be something wrong in the management, when it was the only case where water was refused. A very little inquiry was enough to show the reason. The company was not allowed to manage its own business. Fancy the Government allowing the company to invest money, and then saying we will manage it for you. The first question was this. Suppose the company were allowed to manage its own affairs and sell its own water, would it not have tact and intelligence enough to get over these difficulties with the natives? On this point he might mention that the Soane Works had only just been opened, and yet 270,000 acres were under irrigation immediately they were opened. On this point he quoted from a speech of Mr. Eden, who stated that he had been told that the people would sooner be left to bear the risk of famine than adopt irrigation, and that the water of the Soane was destructive of food; but shortly after this discussion took place he had practical proof to the contrary, for directly there was a drought the people clamoured for the water, and they were forced to open the unfinished works, in order to supply them, and most luxuriant crops were produced on 200,000 acres, whilst on the unirrigated portion of the country hardly any vegetation was to be seen. Nothing but this ocular demonstration could have convinced him of the enormous benefit conferred on the people by irrigation. He adds that he saw what everyone admitted to be the finest crops ever seen in Behar, for 60 miles along which he drove. The ryots of Trichinopoly had lately addressed the Governor, saying it was there that the earliest triumph of hydraulic science was achieved, in the construction of a grand anicut which had converted tracts of arid land into scenes of matchless fertility and wealth, and asking that the system should be extended. That was the way in which the Ryots appreciated the benefits of irrigation, and then they were represented as poor creatures whom you could do nothing with. And it was said that Englishmen were full of energy, life, and activity, and if it were not for these poor creatures who would not use the water when they had it, we might do great things. That was the way in which the matter was mis-represented to the British public. With respect to navigation, it was stated in the paper that the Ganges canal had never been effectively navigated. But what was the reason? When he inspected that work and talked to the head of the traffic company on the canal, he pointed out to him six essential defects in the navigation. One was that the bridges were so low that loaded boats could not pass under them. Since then the bridges had been raised. But when he was at Cawnpore the locks which connected the canal with the river were not allowed to be used. There was in fact a determination to prevent the canal being used for traffic, and wherever there was such decided antipathy to navigation on the part of the officers in charge of the works, nothing could be done. If you committed any enterprise to a man, you must secure that he was heartily in favour of it. Speaking from 50 years' personal knowledge of the country, he desired to say that every one of the objections stated had not a shadow of foundation. If only a thoroughly independent committee were appointed to investigate the matter, it would all come out; and that was all he wanted, a really public, thorough investigation of the case. Every official, without exception, held him up as a poor, ignorant, rash, drivelling creature, who had been of some use formerly, but was now perfectly *passé*; and all the newspapers refused to receive his communications. Any one might write anything against him, but no reply was allowed. He was not allowed to answer Sir James Stephen, nor Lord George Hamilton, in any paper whatever. But he had now written answers, and printed them, and any gentleman who wished to see them was welcome to a copy. In conclusion, he would only say that, when he had on his side the head railway engineer of India, the Government of Bengal, and Lord Mayo, in respect to the great fundamental point which he had insisted on 25 years ago, he was surely entitled to be heard.

Sir George Balfour, K.C.B., M.P., said he was much indebted to Mr. Thornton for his able paper, and he was sure that Sir Arthur Cotton, although he did not agree as to the conclusions come to, would be the first to acknowledge that Mr. Thornton was labouring for the good of India. It was now 25 years ago since he (Sir George Balfour) was appointed a Commissioner to inquire into the public works of Madras, in consequence of the pressure put by the people of England on the Government of India. The labours of his friend, Sir Arthur Cotton, were brought under the notice of the Commission, and though at that time he had not the pleasure of his personal acquaintance, he could not fail to appreciate the great service he was rendering to India. In fact there was no one he knew of in England or India who deserved so well of the people of India as Sir Arthur Cotton. He was induced to make these remarks because only a week ago in his place in the House of Commons he had listened to remarks, which he must say were unworthy of those who uttered them, against Sir Arthur Cotton—words which ought nc

to have been uttered by an Under Secretary of State for India. And at that time he felt compelled to say he was deeply grieved to see a young statesman who might some day rise to high office, forgetting the proper respect due to a great public servant. Coming to the immediate question before them he would beg Mr. Thornton to view the irrigation works in the Madras Presidency in a more liberal spirit than he had yet done. He would beg Mr. Thornton to bear in mind that the irrigation works of Madras were very much in the same state in reference to the present population as the works were in 1852 with reference to the then population. The works were then much out of repair, and even at the present time Mr. Thornton could not fail to have seen in Sir Richard Temple's report, passage after passage, in which he spoke of the great defects of the works. He would call his attention to one point particularly. In the district of Cuddapah, one of the three districts which suffered most from the famine, in an area of 3,500 square miles there was a population of 500,000, and there were no less than 4,000 tanks. Sir Richard Temple reported that many of them were under repair, and that most of them had been long out of repair, and he said it was the more to be regretted to see those 4,000 tanks in this dilapidated state, because they were the very heart and life of the country. Those few words expressed in the strongest manner the kind of work which was required, and very much the same words would apply to many other districts. He would also remind Mr. Thornton of the way in which Madras had been treated. Until Sir Arthur Cotton began to execute irrigation works there, from the very beginning of the century when we took over the country, not one new tank had been constructed by the English Government. That was stated by a Commission 25 years ago, and not only that, but the tanks which the native Government had made were neglected and allowed to fall into dis-repair. He believed the report then made produced a great effect on the Government, and it certainly fell like a bombshell amongst the officials, and incited them to do their duty. Since then great things had been done. No less than eight millions of acres had been brought under cultivation, and he believed about two million additional acres had been irrigated; but so defective were the statements, and so imperfectly had the India-office done its duty, that, although it was 12 years since inquiry had been made as to the extent of land irrigated, even now Mr. Thornton could not say what that extent was, or what was the revenue derived. He believed that about five million acres in the whole presidency of Madras were now irrigated, and that the revenue derived from them was about £2,170,000, whilst unirrigated land produced much less. At all events it was quite certain that the irrigated land was infinitely more valuable to the Government than that which was not. Besides this, from every acre which had been irrigated the Government had reaped a great benefit, because people were able to take up the land still lying waste. In 1852, the revenue of Madras was £4,700,000, whilst it was now £7,700,000, aud, in fact, no part of India had progressed in so remarkable a manner. There was an increase of three millions in the revenue compared to what it was 25 years ago, and the Government of India had not, since taking possession of the presidency, spent two millions in executing irrigation works. Again, looking at the accounts of the presidency, there was no part of India which yielded so large a surplus of revenue over and above the cost of civil government. Although both its area and population were considerably less than that of Bengal, the surplus revenue was considerably greater. That was a point he begged Mr. Thornton to take a note of, and he need not say he should be very happy to supply him with the necessary data referring to Madras. Much of this prosperity was due to Sir Arthur Cotton, who had also been connected with works in the southern part of India; in his younger days there were recurring famines year after year in the districts of the Godavery, but no one ever dreamt of a famine there now. In 1833, it appeared from the report on public works, that in one of the districts now watered by the anicuts thrown across the Kistna and Godavery 250,000 people actually died, and many thousands of cattle also died, leaving the people destitute, and he believed that more than two millions sterling worth of property was lost. That was equal to four times the amount spent in making the anicut, which had now made that country into a perfect garden. With regard to the quantity of water, he had often, when on the banks of the Toombuddra, seen night after night sufficient water flowing down to irrigate the whole of India. The only thing required was to have it spread over the land. He hoped there would be a full investigation into the affairs of the Madras Company. They had spent one and a half millions in constructing the works which had been so much abused, and the Government, instead of allowing them to have the water from the river so as to irrigate the land during the whole year, only allowed them to have it from the 1st of June to the 1st of September, but the Ryots would never submit to have their land subjected to irrigation at one time, and be deprived of it at another. That, he believed was the main cause why the company was not successful.

The Chairman moved the adjournment of the debate until Tuesday evening next, and as he might not be able to be present on that occasion he wished to make a brief allusion to the personal question which had been raised. He had not of late years had the pleasure of much acquaintance with Sir Arthur Cotton, but as he knew, he had always held him in the highest respect. He was a man who had done great services to his country, and who had that rare gift of genius which few possess. Many men might have done services as zealous and industrious, but they had not that Promethean fire which he possessed, which enabled a man to influence all who came near him, and to leave his mark upon his age. Although he had never had the honour of his intimacy, he was intimate with many of his friends and acquaintances, and they all loved him. Could not Sir Arthur Cotton, with all these precious gifts of genius, honour, love, and troops of friends, and a useful life to look back upon, find anything better now than to go about England reviling those who served in the same service, who had worked as laboriously, and as zealously, and as heartily as he had, but who had not that God-given spark of genius which he possessed? In those speeches which he made at Manchester, and supported others in making, he did so revile those who were working as conscientiously as he was himself for the good of India, and ignoring all that they had done and were doing, ignoring the fact of the millions that had been devoted to irrigation works and other improvements, he treated all that as if it did not exist, and spoke as if there was no one in the Government of India who recognised that irrigation was needed, and said that instead of the want of water which was alleged—(which he had not heard alleged)—there was a want of brains. Men who used hard words must expect hard words, and this was the apology for those hard words (otherwise he must confess most undesirable) which had been used against Sir Arthur Cotton. He would say no more, but he had taken this opportunity of saying this because it had long been in his heart to say it, and he had only been waiting for an opportunity of meeting Sir Arthur Cotton to say it.

Sir Mordaunt Wells seconded the adjournment, which was agreed to.

The discussion was resumed on Tuesday evening, the 26th, when the chair was taken by Mr. Hyde Clarke.

Sir Mordaunt Wells said he had listened with much attention to the able, and in some points instructive

address of Mr. Thornton, but looking at it in a practical point of view he was much disappointed, especially considering the position he occupied at the India Board. He thought the time had altogether passed for discussing this question either on personal, or, if he might use the expression, philosophical grounds. The time had come when it must be viewed in a practical way. We must see what had been done, and what could and ought to be done; because, after the lecture of General Strachey and the able paper of Colonel Chesney, in the "Nineteenth Century," few men would be bold enough to contend that irrigation for India was not feasible. He must say, with the greatest respect, that the lecture given by Mr. Thornton failed altogether to grapple with this question practically. Holding the position he did, the public had a right to expect that when Mr. Thornton lectured on this subject he would put forward something practical, which they could work upon in the future. He did not say that Mr. Thornton was speaking the opinions of those under whom he served, but when he remembered the speeches delivered at Manchester by Lord Salisbury, and what took place in the House of Commons, he thought he was not doing him any injustice in saying that he had been inspired by the views which prevailed in that department of the Government. If not expressed in direct terms, there was running through the paper an attempt to throw cold water on the carrying out of irrigation schemes in the presidency of Madras. Now when Mr. Thornton was speaking, he thought the words of Col. Chesney must have crossed his mind, that irrigation had saved the North-West Provinces in the future. Considering that in Orissa there was the same state of things, although as suggested elsewhere, there was the great difficulty with respect to dealing with the natives with regard to the compulsory taking of the water; considering that the area of the Madras presidency was something like 148 million square miles; considering the amount annually laid out by the Government, in 1873-4-5 and 6, he said the Government of India and the Government of England had both neglected, in a remarkable degree, the improvement or even the completion of existing works, and the making of new ones. The amount of land revenue in Madras alone exceeded 21 millions sterling, and viewing this question practically it must be remembered that there was a relationship existing between the Government and the owners of property which was scarcely known in any other country. In fact, the Government was the great landlord of India, and in speaking of the Government spending vast sums of money in irrigation works, it must be evident that they were doing it in their own interests, and not merely for the welfare and preservation of the lives of the inhabitants. If these irrigation works were not carried on in Madras, there would be a return of the frightful disaster which so recently occurred. There would be the same loss to the revenue, the same amount of distress, and, therefore, the landlords had a right to look to the expenditure of the money not as so much wasted, even if the return was not alone perceived. How did the matter stand? In the Punjab, the area of which was not greater, ten times as much had been expended as in Madras, though unfortunately not on any system, because, up to the present moment, there had been no system, either in India or England, showing what works were required and how they could be executed. It seemed to him very strange that the Government had dealt with this question in Madras in the way they had. He had travelled over the greater part of the famine districts in Madras, and had paid special attention to the subject; the area in square miles was 138,318, and the population, excluding Mysore, was 31 millions. Now, in 1874-5, the extraordinary expenditure on irrigation works was £59,408, and the ordinary expenditure, £26,927. In 1875-6, the extraordinary expenditure was £59,408; the ordinary, £43,935; or, a total in the two years of £189,678. Was that keeping faith with the public, and could Mr. Thornton say that irrigation must stop? If this was the way in which the Government intended dealing with the question, it was altogether trifling with the people of India; and it was evidently impossible that any large works could be carried out if that were the principle adopted. Mr. Thornton had suggested—and he was surprised at his doing so, after what had befallen the only scheme unconnected with the Government in Madras—that, if the people of England were dissatisfied, the best thing they could do would be to put their hands in their pockets and construct works which should be profitable; but he even qualified that, by saying that he should be sorry to see the money taken out of the pockets of the people of India and transferred, as profits, to capitalists in England. He took it, therefore, that this was a kind of *ad captandum* observation, with reference to what had been said elsewhere; because he knew that, if irrigation works were to be carried out in India, it would not be done by private enterprise. It could not, because although so little had been done, the greater part of the ground was occupied by the Government. He did not agree with all the views entertained by Sir Arthur Cotton, but at the same time he fully recognised the enormous good which had resulted from his enthusiasm. Everything was done by enthusiasm and perseverance, and although some of his deductions might be incorrect, still the good he had done was enormous. He could say much more, but as time was short he would leave the matter in the hands of other speakers.

Mr. Maitland said that he had lately seen an article in the *Bombay Times*, commenting upon the meeting held at Manchester a short time ago, in which regret was expressed that gentlemen should have taken up such a line of antagonism to the works undertaken by the Government of India, as had been done by Mr. Bright and others. To his mind, while Mr. Thornton's paper was very valuable for the reliable information it contained, there was still a greater advantage in it, viz., the calm, moderate, and reasonable tone in which the paper had been written, and if all discussions upon important subjects were conducted in this manner a better result would be arrived at. It had been stated over and over again that railways in India were not a success, but he might say having seen a great deal of them, that this was not the case, as would be seen by a glance at the price at which the stock was quoted. Seeing that railways had been such a great success, he thought they should go to the Government and ask it to take up the question of irrigation wherever it was believed that it could be conducted successfully. All he understood Mr. Thornton to say was that while irrigation was not a panacea for everything, it was a very good thing if properly conducted in proper places. Mr. Thornton had stated that 50 millions might be very quickly expended, and Sir Arthur Cotton had complained that public works in India had been made in a sort of intermittent manner, and therefore he hoped that whatever Government did in the matter would be done quickly. Every one knew that the finances of the Indian Government were not in a flourishing state, but still he did not think any one with rea knowledge of the subject would say, with Mr. Bright, that they were on the verge of bankruptcy. If the Government had waited till it was in a position to construct the railways out of its ordinary revenues, the lines would not have been made to this day, and therefore he could not see why the Government of India, in cases where they were satisfied that the works would be beneficial, should not do as the Governments of South Australia and the Cape of Good Hope had done, namely, borrow the money. If they came forward and said they wanted the money for irrigation purposes, and proved it would be a reasonably good investment and do an immense amount of good to India, he had not the slightest doubt but that they would get more than was requisite for the purpose.

Mr. Edwin Chadwick, C.B.—I beg, as an accredited political economist, to offer some observations on some leading principles touched upon in the discussion of questions as to the irrigation works. The dividend yielded upon irrigation works has been treated as the sole test of their utility. Now I apprehend it will be found that the means of the conveyance of water, like the means of the transit of goods by roads, will frequently yield their return in the increased production, and value of land where they yield no return in tax or toll. In America, in New Zealand, roads are cut at a direct loss in the construction and the maintenance of the road, for the increase of the value of the contiguous land. Railways have paid largely to landowners in this country, where they have paid little or nothing to the shareholders. The profit on water conveyance will frequently be, not on the water sold, but on the crops raised by it; and this is especially the case where, as in India, the State is the landlord. As an economical rule, of all taxes, those on transit, by tolls or by dividends, are the most wasteful of taxes. I would now, however, call attention to a primary economical condition of our rule in India, which has not hitherto, so far as I am aware, or as Indian statesmen have told me that they are aware, been noticed, a condition that may at first sight appear to be beside the present subject, but which goes to the foundation of the subject, namely, the capital available for the future cultivation in India. And that condition is the relief afforded by the great reduction of the burthen of non-productive military force which our rule, as compared with any other, gives to India. We hold all India, with its population of two hundred millions, mainly by an effective force of not more than sixty thousand British soldiers, aided by a native force—altogether, by a quarter of a million of force, as compared with three millions of unproductive military force which burthens equivalent European populations. Productive our force is, however, in maintaining internal security and production, for which it suffices. I take for illustration, by comparison, the presidency of Bengal, which has a population of upwards of 60 millions, the equivalent of the population of the empire of all the Russias, before its heavily burthened and, under militarianism, its losing annexations. Let the recuperative power, under the one rule, be compared with the other? If Bengal were restored to its native rule, it would inevitably return to the subjection and charge of an unproductive military force of diverse States equivalent to that of Russia. To the extent of the saving of unproductive force by the British as compared with the native rule, means are gained (whether as yet applied or not), for such productive purposes as those in question. I beg to advance another illustration. A deceased Indian statesman, and lamented sanitarian, and friend of mine, the late Mr. Robert Ellis, of Madras, visited Algeria on a sanitary mission with others, to examine a case of sanitation. He observed the rule there, when he declared that he would hold all Algeria with less than one-third of the force with which it was then held under Marshal McMahon, of upwards of eighty thousand men *i.e.* more force, for that population of four millions, than we have for the Indian population of two hundred millions. Since the occupation of Algeria, France has expended from three to four millions annually, wastefully and unproductively. Estimate what might have been done under Indian rule, with a saving of two millions per annum, or upwards of eighty millions applied to works of drainage, irrigation, and other works of sanitation, colonisation, and production! In further illustration of the economy of our Indian rule, I might instance the bankrupt rule of the Turks, that in Egypt, and take one item to begin with, of a barbarous civil list of a million per annum, which, under Indian rule, would have sufficed to have cut the Suez Canal; or the rule of the Turk at Constantinople with a civil list of two millions per annum expended in barbarous corruption, in addition to the expenditure of an army double that of all our Indian army, native as well as British. What might not have been done with such resources under our Indian rule. That rule, with all its short-comings, which it is our business to look up, as means for further improvement, will be found to be the best of any that has ever existed, or of any that exists for subject populations, save, indeed, according to report, the rule of the Dutch in Java, where they have advanced upon ours, amongst other things in the payment of civil administrators by the results, an economical element that works there admirably. This thesis requires further development. I will only say that the principle will, in its practical application—for which time and confidence are required—afford the means of obtaining capital in the very poor districts of India for the works required there. My son, who has served in India as an officer of the Royal Engineers, has declared, as others have done, that there is much hoarding now going on there; that capital is now hoarded and accumulating amongst the natives, which, with the growth of confidence and with proper means, may be brought out there for the advancement in India of the works in question, for which he, for one, had what I believe to be a very sound scheme. In my view, one of the foremost means of improvement, especially as to irrigation works, will be in the competent and independent examination of past works to ascertain what does not do, for better guidance as to what will do. Of this I might furnish examples of irrigation works where there has been great waste of water, with the result of creating marsh surfaces and malaria; and of expensive town drainage works with the results of the extension of evils intended to be removed. The uncertainty of the sources of the supplies in the Himalayas stated by Mr. Thornton might be cited as a condition which ought to be removed by scientific examination and observation.

Mr. Haddan, C.E., said he wished to point out that the question of famine was entirely one of intercommunication. He had seen famine rampant within 100 miles of where the crops were rotting on the ground, and this was caused by the people not keeping stores of grain. Irrigation had been spoken of as a preventative of famine, but in the district to which he referred the irrigation was simply perfect. They suffered for two or three years from drought, and the subsequent year they had a magnificent crop, but they could not sell it; the consequence was that many persons were ruined, because owing to the former bad years they had to borrow grain for sowing purposes at such an exorbitant interest that they could not sell it at a profit. Had there been a market, a good crop would have been a blessing instead of being, as it was, a curse. Therefore he thought that proved that irrigation had nothing whatever to do with the question.

Mr. Elliot said the question of irrigation, like all other questions, resolved itself into one of money; and if that question could be answered satisfactorily in the first instance, they might then go into the question of irrigation, but if not, all the discussion upon the subject would be utterly useless. To arrive at a sound opinion as to whether England should lend 40 millions to India for irrigation schemes, they must consider what was its public debt compared with its income, and whether it was advisable to furthor add to its enormous public debt. The public debt of India, including the guarantees upon the railways, was 230 millions, and the income from taxation was only 38 millions. That was the only income that could be relied upon; but the sum derived from opium, and so on, might be cut off at any moment. From those figures, it was plain that the liabilities of India were six times those of England; and yet there were persons who advocated the increase of that liability by borrowing enormous sums of money for irrigation purposes. If the money could be found in India, he would say, borrow it at once, and lay it out in irrigation works; but he

strongly deprecated the idea of the money being raised in England. He considered, with the lecturer, that the growth of trees in any country was a very important matter. It was an old saying, "if you kill the weasels the rats increase;" and in the same way, if the wood and forests were destroyed, springs dried up, the rainfall was diminished, and the country was at last reduced to a desert; and thus it was that they found cities buried in the sand. This process of destruction had been going on rapidly in India, and was the great cause of desiccation of the climate.

Mr. Andrew Cassels remarked that the discussion appeared to be nothing more or less than an indictment of the Indian Government; and he might say he had heard a great deal stated that was most untrue and unjust. No one had a greater admiration for Sir Arthur Cotton than himself; but he must say he rarely listened to, or read, one of his speeches without feeling deep regret and pain. He fully recognised the earnestness with which, in the great cause of humanity, Sir Arthur Cotton pleaded for these works of irrigation; but the exaggerations in which he often indulged, his unwise depreciation of railways, and his constant denunciation of the Indian Government, had done more injury to the cause which he (Mr. Cassels) and others, as well as Sir Arthur Cotton, had at heart than was imagined; and he ventured to say that the way in which he had spoken of the matter of late years had made ten enemics where it had made one friend. Did anyone suppose that the Government of India was so blind or so stupid as not to wish to carry out works calculated to do good to the country. He defied anybody to show that any Government in the world had done more during the last 25 years for the benefit of the country than the Government of India. The increase in the population of India proved this. He ventured to say that Mr. Bright's speech at Manchester bristled with misstatements and mistakes. Mr. Bright had stated that to prevent famines they should lay out in India 30 millions on works of irrigation. He wondered whether that gentleman knew what he was talking about; his own opinion was that ten times 30 millions would not prevent famines by means of irrigation in an empire with so large an area as India. India was a very poor country, and the money required for these immense works could not be raised there; but if it were raised in England, the drawings of the Council of India necessary to pay the interest on the debt would have to be increased. Now, as a merchant, he knew how the trade of India was disturbed already, by the fact that some 16 or 17 millions annually had to be sent to England in excess of the exports; and if that were increased, the commercial difficulties would also increase year by year. All this should be borne in mind; and people should not let their impatience get the better of their judgment, and accuse the Indian Government of want of heart and want of brains because it did not see the means of doing what was desired. Again, as to the railways; did people forget what railways had done for India? They had saved millions of lives during the last twelve months. He sometimes thought that even in England railways were not appreciated as they ought to be; and though our wonderful progress was attributed to free trade, seeing that railways and free trade came in together, a great part of the benefits attributed to the latter were, in reality due to the means of rapid and cheap communication. When people denounced the Government of India they were using words which had no real meaning. Another subject, intimately connected with the prevention of famine, was the state of agriculture, which was lamentable in India. Of scientific culture of the soil there was none; and he did not speak merely of his own knowledge, as would be shown by a few passages he would read from a minute issued by the Indian Government in the time of Lord Mayo. One stated that agriculture occupied the great mass of the people; but it was susceptible of almost indefinite improvement, and that on its development depended the whole material and commercial progress of the country, because, for centuries to come, the main staple of exports must be agricultural produce, which were also necessary to furnish the raw material for any other industrial occupations. Another passage was to the effect, that it was hardly too much to say that scientific agriculture had in India, at present, no existence. Here, then, was a practical way of improving the resources of India, and preventing famines; for notwithstanding all that had been done by the Government since this minute was written, he still believed that the state of agriculture was lamentably deficient.

Mr. George Foggo said that in December last Sir Arthur Cotton read a paper on "Irrigation and Indian Famines," at a meeting of the East India Association, very similar to the one he read at Manchester, which had attracted so much attention, particularly, no doubt, from the endorsement which Mr. Bright there gave to it. He then proposed a resolution, which was carried unanimously, "That the Association should take the paper into early consideration, with a view to forming a deputation to wait on the Secretary of State for India and urge upon him the expediency of giving due consideration to the views of Sir Arthur Cotton, and the application of irrigation on an extended scale to India." At the following meeting in January, the subject was again discussed, and after considerable difference of opinion had been expressed, some members saying that they did not like to endorse Sir Arthur's views as a whole, it was determined to postpone the decision until after Mr. Thornton's paper had been read. The reason for moving the resolution was, that considering Sir Arthur Cotton's position, character, experience, and great services to India, and the great importance of the subject to the people of that country, he thought that some answer to that paper was very desirable, if possible, an official answer. He much regretted that Mr. Thornton had not, so far as he could gather, attempted to answer any of the questions put, or the allegations made by Sir Arthur Cotton. After reading one or two extracts from this paper, which the Chairman said was hardly necessary, seeing they were, no doubt, fresh in the minds of the audience, Mr. Foggo said he would content himself then in putting one or two questions of his own, which if the India-office ever came down to the level of ordinary human beings, he hoped would be answered. 1. How is it that, after a century of British rule and fifty years experience of famines, there is to this day no settled and permanent policy in regard to irrigation, and how was it that any inquiry into the subject to regulate that policy can be necessary? 2. Is there any prospect or expectation that the inquiry just ordered by the Secretary of State into the question of famines in the Madras Presidency will lead to the adoption of a settled and permanent policy? 3. What has been the aggregate cost to Government of the several famines, say from 1830 to the present time, and what has been the aggregate amount of loss on irrigation works, and what the aggregate amount of profit thereon? Major Chesney had told them that although the cost of irrigation works was very great, the cost of famines was much greater. 4. Has not the Secretary of State for India, in his despatch of the 10th January last, in effect endorsed the dicta of Sir Arthur Cotton, that irrigation works are the one thing needful; that not the per-centage of profit only, but the total results of the irrigation works, must be incomparably the chief question, when he wrote:—"Works of irrigation are naturally the most effective remedy for a deficiency of rainfall, and no doubt can be entertained of the benefit they confer, whenever they can be had without excessive cost, and where there is a permanent and sufficient supply of water to sustain them;' and further:—"In view of the frequent famines of recent years, it must be admitted that the value of an irrigation project is not absolutely negatived by the proof that

it will not yield full interest on its cost. The case is conceivable that a canal which paid little or no interest in ordinary years, might in a famine year protect so large a population as to repay to Government the cost of its construction by savings in relief expenditure."

Mr. J. T. Wood would have thought that any one who had listened to Mr. Thornton's paper would have felt satisfied that the fullest inquiry had been invited, and that attention had been specially directed to the most material points; and he did not conceive there could have been any necessity for Mr. Cassels to get up to defend the Government of India; because the paper showed that the Government was doing everything in its power to promote the cause of irrigation. He believed that that cause had been much damaged by want of attention to the simple question of accounts, and by the looseness and inconsistency of the statements made and estimates given. He might illustrate this by something which fell from Sir Arthur Cotton on the last occasion, when he spoke about the project of Mr. Leslie for cutting a canal by the side of the Eastern Bengal Railway, between the Ganges and the Hooghly. Mr. Leslie was a most distinguished engineer, and the estimate he had given was, no doubt, the best he could form, but he said that the cost of that canal would be £2,000,000 for 130 miles. He could only say that the original estimate for the way and works of the Eastern Bengal Railway, which was 28 miles longer, was less than £2,000,000, so that it appeared that the steam-boat canal would cost more than the first-class railway running along side of it. They had heard a great deal about the cost of carriage by steam-boat on a canal as being only $\frac{1}{20}$d. per mile, but Mr. Leslie's estimate of 42d. for the whole distance was much nearer $\frac{1}{3}$d. per mile. Further, they were told that the quantity of goods to be carried was 1,900,000 tons, and the estimate given by Sir Arthur Cotton was, on the assumption, that the canal would carry the whole of those goods; but if this were so the Government would lose something like £200,000 through the goods not being carried by the railway, and the railway would lose the carriage of about 383,000 tons of goods. After all, if they took the printed papers and speeches of the great advocate of irrigation, and subjected them to the fullest criticism, rejecting all that was irrelevant and offensive to other persons, and correcting the figures, what did it come to but that the case made by Sir Arthur Cotton was so strong that it called for further inquiry. The Act of Parliament in England required that a separate debtor and creditor account of each sum advanced under the Drainage Acts should be kept by double entry for each advance; and what was wanted in India was to keep the accounts of the main channels of irrigation separate from those of the main channels supplying each sub-district.

Mr. Hale said he had not understood Mr. Thornton to oppose irrigation, but simply to question whether the case had been made out for holding that it would be a perfect preventive of famines.

Mr. Wm. Botly had intended to say something on the subject of the planting of trees, and also as to the improvement of agriculture in India, on which point he agreed with Mr. Cassels, but as time was short, he would simply say how pleased he was to notice in the concluding portion of the paper a reference to the important point of security of tenure. In any country this was most essential in preventing scarcity, and he was glad therefore that it had not been lost sight of.

The Chairman said it would be giving him great pleasure to take part in the general discussion of this subject, but he must confine himself to a very few observations in proposing a vote of thanks to Mr. Thornton. In his view, that gentleman had not been guilty of any omissions, and could not be blamed for the mode in which he had treated the subject. Some speakers had endeavoured to show that irrigation was the chief, nay, almost the sole remedy for famines in India; but Mr. Thornton's object was rather to call attention to the whole of the subject, which had been so well understood by many other speakers. He had shown the immensity of the subject, and they were indebted to him not only for the paper, but for the discussion it had elicited, especially at the hands of Sir Arthur Cotton. He should have liked to call attention to one point which had been noticed, viz., the importance of endeavouring to obtain substitutes in fuel for the manure which was largely consumed for this purpose. The more they could develop the mineral resources of India, and extend the supply of coal to those districts where manure was burned, the greater saving would be effected in that important direction. He thought they must all agree that the position of the Government of India had been better explained and stood forward in a clearer light for the discussion which had taken place. Attacks on the Government, and on its officials, had been repeated on this occasion, emanating from men who had spent their lives in the service of humanity, and who had conferred the greatest benefits on India, and who were looked upon by the Government as the ornaments of the service, and by Englishmen as the honour of their country; but though reference had been made to the hundred years during which we had governed India, none had been made to the task we had then to perform, namely, to protect India from foreign war, internal dissension, dacoitee, and even from mutiny. Although they had heard the Government of India reproached as if it had been the cause of a deficiency of food for its population, yet the facts brought forward showed that there must have been, under English rule, an enormous increase of food, because there had been an enormous increase of population. Without referring to the facts mentioned by Sir George Balfour as to the increase in the population of Madras from 22 to 31 millions, the census of India, after allowing for all imperfections, would show a greater increase of population than had taken place in the greater part of the empire. In fact, in many parts of Europe population was stationary; in India it had largely increased, and it showed an increase of food. This fact alone was sufficient to acquit the Government of culpability; but the absolute duty of the Government for years was to fight in the field for the safety of the population, without which these great benefits could not have resulted. After all, what was the production of food for five millions by irrigation in proportion to the food for at least fifty millions, which had been the general result of our administration. Considering, further, the absolute necessity there had been in India for the provision of means of transport, and the development of the railway system, it was evident that at least the Government had done a great deal for the welfare of the population over which it ruled. He should rather demur to the doctrine laid down by some and supported by Sir Mordaunt Wells, that we were to look on the Government of India as a landlord, in the sense of an European landlord.

Sir Mordaunt Wells said he had not meant his remarks to bear that signification.

The Chairman said the word landlord was used. There were other Governments which held a title over the land, and he would put it to such an old student of jurisprudence as Sir Mordaunt, that landlord could not be applied to the position of such a Government as that of India, which did not receive the rent for its own purposes like an individual, rendered the ordinary consideration inapplicable. It had been intimated that the great works executed by our predecessors were works of benevolence, but he apprehended the true conclusion was that they were carried out by means of forced labour; and one merit we could claim was that the greater part of the works we had carried out had been effected rather by our own exertions than by

increasing that burden on the population. In some parts, no doubt, burdens had been increased, but, looking at the broad results, it must be admitted that the condition of the population had greatly improved under our rule, and must at least be equal to that in which it was under the best Governments, legendary or historical. Perhaps it was, in many cases, because we had not carried out the system of forced labour, that these works in India were not in the same condition as those in Egypt, to which reference had been made. After all, there were natural laws which lay at the root of this question of famines. It had been lately connected with sun-spots, and this was supposed to be peculiar to India, but the same thing would be found to apply to this country, as he showed in 1845 in his "Physical Economy." Examining the records of the prices of corn for 600 years, it would be found that there was the same recurrence of a ten-yearly period; but he feared that the scientific men who had lately attempted to connect these Indian famines with sun-spots would find an equal difficulty in prophesying years of prosperity or famine there, as he had in England, because although they frequently found these shorter periods recurring almost at the time expected, it was evident that there was some greater cycle which came in to disturb them, which either intensified the famine at a particular period, or brought a period of prosperity instead, and even when they had apparently ascertained that period, there was again evidence of a still greater period which came in to disturb all their calculations and render them futile. He should have been glad to have entered more fully into the discussion, but as it was necessary to allow Mr. Thornton time to reply, he would conclude by moving that the best thanks of the meeting be awarded him for the very valuable paper he had read, and which they all acknowledged.

The resolution having been carried unanimously,

Mr. Thornton said the wish he had expressed at the beginning of his paper that the poverty of the text should be compensated for by the abundance of the comments had been amply fulfilled. The commentary had been replete with valuable suggestions; but he should, in his reply, confine himself to those points in which he had been impugned, nor should he reply to everything which had been said affecting himself. Sir Mordaunt Wells thought it exceedingly undesirable that such a subject should be treated from a personal point of view, and, taking that hint, he should pass over all personal reflections on himself. One suggestion he had made was, that whatever irrigation works might anywhere be constructed, the quantity of water available for their supply could not possibly be unlimited; that even canals fed by the Himalayan rivers might easily be so extended that much of the land irrigated by them in ordinary seasons would be left absolutely dry in seasons of extraordinary drought, and that then much of the population, which the extended irrigation had brought into existence, would simply become an addition to the multitude of sufferers from famine. If this could be said of Northern India, the remark was still more applicable to the south, where the greatest rivers, the Cauvery, the Godavery, and the Kistna, were mainly dependent on the fag-end of the south-west monsoon, and where the minor streams, which took their rise farther to the east, whose main source of supply were local rains, must necessarily become less able to supply the water required, when it was most needed, by reason of a failure in the local rainfall. In reply to that, it was objected that the average rainfall of India was between 4 ft. and 5 ft., implying that the total rainfall received from the skies in the course of the year must be abundantly sufficient for the irrigation of the whole of India. He was quite willing to accept that, and, indeed, it was probably understated, for the rainfall of India, according to the highest authority, was much nearer 10 ft. than 4 ft. No doubt, as he had said, if India were girdled by a wall of brass, the whole of the enclosed space would at one time of the year be a lake, passing into a pestilential swamp during the remainder; but, unless some such expedient were adopted, a very large portion of the 110 inches of rain which annually fell must necessarily flow uselessly into the sea. Not to perceive this was to forget that while, on the one hand—*pace* Sir Arthur Cotton—water could not run up hill; on the other hand, it must run down hill. Take the greatest monument of Sir Arthur Cotton's genius, the anicut over the Godavery, 2½ miles long, 130 ft. thick, and 12 ft. high; the quantity of water arrested even by that gigantic dam was a mere nothing in comparison with the quantity brought down, for, while in the rear of the dam there was a reservoir of, at most, 12 ft. deep, from 7 ft. to 14 ft. of water were continually passing over the crest when the river was in flood. Perhaps it might be said, why not raise the anicut? Well, to raise it by 14 feet would at Rajahmunday be simply impossible. But suppose it were possible, what then? Plainly, that the water would be pushed back up stream as far as the banks were lofty enough to keep it in, and until it came to some lateral outlet through which it would rush in an irresistible torrent, and, after sweeping away everything before it for perhaps hundreds of miles, would finally reach the sea as before. He was not without warrant, therefore, in saying that the quantity of water available for irrigation purposes was not unlimited. Another argument he had used consisted in repeating a phrase as to the inability of water to run up hill, for which he believed the Marquis of Salisbury was primarily responsible. He had pointed out that inasmuch as no irrigation work, whether tank or canal, could be so situated that the land would slope from it in every direction, it necessarily followed that there must be in the neighbourhood of every irrigation work a great deal of land which could not be irrigated from that work. In the table land of the Deccan, wherever the rivers had cut a passage for themselves some hundred yards below the surface, it was preposterous to dam up the river for the purpose of irrigating the plateau overhead. Sir Arthur Cotton said that if there was one thing which astonished him more than another about this aphorism of Lord Salisbury's, it was that anybody should be found to repeat it, yet all that he can adduce in refutation is that rain falls on the tops of hills as well as on the coast, and that there is one great tank 7,000 feet above the sea; *ergo* that water is obtainable at every level from that to the coast. With all humility, however, I submit, firstly, that although 100 inches may fall every year on and about the Western ghauts, the portion thereof available for the purpose indicated by Sir Arthur Cotton is merely that which falls on the summits and slopes of the ghauts themselves, since whatever falls between the ghauts and the adjoining sea is completely cut off, and whatever falls east of the ghauts is already at a level a good deal below that of much of the Deccan table land. Secondly, that doubts may reasonably be entertained as to the sufficiency, for the irrigation of the whole Deccan, of 100 inches of water, multiplied by only the length and breadth of the slip of land covered by the ghauts. Thirdly, that to render even that water available, it would be necessary to convert all the clefts and gullies, and ravines of the ghauts into a connected system of reservoirs; and fourthly, that even if the water were stored in adequate quantities and at suitable heights, still to distribute that water over the Deccan would require not canals, excavable at a cost of £1,000 or £2,000, but more probable canals carried along the tops of stupendous embankments, and of long lines of masonry arches, and costing as much or more than any of those railways whose expensiveness Sir Arthur is so constantly denouncing. Sir Arthur says he hopes he shall hear no more of the inability of water to run up hill, but he must adduce something stronger in its disproof if he wishes people with whom it has hitherto been an

article of faith to strike it out of their scientific creed. To the doubts expressed by him as to the possibility of combining navigation and irrigation, no reply had been made. No rejoinder, therefore, was required from him. Whether it were true or not that thousands of miles of navigable canal might be made in India which, by affording cheap means of conveyance, would save fifty millions sterling a year to the public, or as much as the whole amount of the taxation, he would not say anything, whatever he might think. He had not said one word in the paper in depreciation of navigable canals; he only questioned whether an inland canal, from which water was being continually drawn off for the refreshment of the sunburnt fields on either side would at the end of 100 miles be likely to contain water enough for boats to float in; and until he could see some canal of the kind he should beg leave to retain his doubt. Then, as to the disrepair into which tanks had been allowed to fall under British rule, he as deeply lamented it as Sir Arthur Cotton or Sir George Balfour, but he did not agree with them in thinking that the British Government was so responsible for it as was commonly supposed. His impression was that under native rule these tanks were maintained, not by the central authority, but much more largely by individual or associated landowners, and consequently it was really those who were to be blamed or rather pitied for having allowed these tanks to go to ruin. At the same time, he agreed that, whatever be the cause of the disrepair, it was the bounden duty of the Government to restore the tanks as much as possible. But he certainly did not think that one word had been said to show that if these ruined tanks were put into the most efficient condition, they would prevent a famine one bit more than those tanks, which had been kept up, but which, nevertheless, during the famine became useless, because there was no water in them. He had now touched lightly upon all the points on which his statements had been impugned, and he did not think he had said anything which could be construed into a desire to discourage irrigation. He was quite ready to repeat what he had already said, that the value of irrigation in ordinary seasons could not be over-estimated, and that in extraordinary years of drought it was absolutely invaluable. But he did not believe it could be depended upon as a preventive of famine; and, moreover, even if it were, it was one which could not be applied on a sufficiently large scale. According to Sir Arthur Cotton's estimate, the total extent of country irrigated in India was ten millions of acres. The works which irrigated them must have cost at least £2 an acre, or twenty millions sterling. The total area of British India was about 450 millions of acres, of which perhaps half might be considered cultivated or cultivable. In order that irrigation, supposing it to be a perfect preventitive of famine, should be applied in sufficient extent to produce its object, it would have to be extended over these 250 millions of acres, at an expense of £450,000,000; in other words, at the expense of the entire revenue of India for nine consecutive years. Sir Arthur Cotton limited himself to recommending that irrigation works should be created everywhere where they could be contructed at practicable cost, but what portion of this £450,000,000 could be considered practical? It was all very well to regard the subject from a humanitarian point of view. It was quite right to do so; but he did not think they need let humanity deprive them of their common sense. He meant to have touched on one other point, but had been forestalled, namely, on the heat of feeling and language which had been imported into the discussion of this subject. If there was one subject more than another in which they might sink individuality, and consider only the great interests at stake, surely this was it. If there was one subject more than another on which no one was entitled to set himself up as an infallible Pope, this was it. There was no chance of solving the problem unless they were willing to assist each other, correct each others mistakes, to regard the main question, and not to turn aside to paltry side issues.

Mr. J. H. Haddan writes as follows:—

When the natural divisions of countries are overcome by a complete system of means of communication, then, but not till then, can the varying fortunes inherent to agriculture be equalised. A scarcity in one province would, in lieu of disaster, positively contribute wealth to its neighbour; and Western principle, as to supply and demand, would then enjoy full swing, and famines might safely be left to take care of themselves.

Now, irrigation is almost always so purely a local matter, that its use or abuse cannot fairly be considered an imperial question affecting the condition of the Empire; while intercommunication, which water may, it is true, contribute to, but cannot completely afford, is both commercially and strategically a State necessity.

Moreover, in isolated provinces where export is impossible, a good harvest is, after a series of bad ones, I have found from experience, a curse to the country in question, since prices fall and the ryot cannot pay either his money, taxes, or the high rate of interest due to the shroff, or native banker, for borrowed capital. To such an one irrigation charges would be a mockery

In Turkey, where roads do not exist, notwithstanding all the irrigation works (which have mostly been preserved), famine may be said to be chronic. The prices of produce vary in different provinces as much as 1,000 per cent., and crops may be seen rotting within a paltry hundred miles or so of patiently endured semi-starvation. The railways and shipping trade have drawn the caravan beasts to the coasts; and in the interior, except during the short pasture season, animal transport of bulky agricultural produce is, for long distances, out of the question, since the animal must carry his own food supply also. The roads, too, are frequently impassable at this season, more especially in the black soil districts. A means of getting to market is really what is wanted. Under such circumstances irrigation would but increase the evil by augmenting the cost of production, while in but rare cases could it yield a *quid pro quo* in the shape of providing an outlet for export, owing to the nature of the country.

Now railways, as we understand them, are too costly; and, what is more, require too much animal labour for their construction; labour, moreover, expended in a form only indirectly and tardily profitable, and therefore not to be compared, from an economist point of view, to the same labour spent in tilling the ground or in the arts. Their construction is slow, invariably deranges the labour market, and the working and administration far too complicated and costly for general transport purposes in out of the way districts. Their influence is also too concentrated for an agricultural country, for, owing to the small value but great bulk and weight of its products, it does not pay to cart any great distance to a railway; nor is it even practicable at all seasons, especially just after harvest, when the monsoon cuts off whole provinces from trade communication with the outer world. Thus the supply of traffic is not regular, and one of the first principles of transport economy are wanting.

In countries like India, where interest on capital is so high, and every native is more or less a pawnbroker, not satisfied with less than 20 per cent., a rapid means of realisation of capital is the only way to promote native investments.

We have the proof of this in the fact that our colossal 5 per cent. guaranteed railways have been made almost exclusively with British capital; want of native confidence had nothing to do with the question, the inducements were simply not sufficient.

Now, for ten years past, I have studied the question of supplying vast continents with remunerative railways (in the Eastern 20 per cent. sense), and I am at last

able to offer a system resembling the spider's web, whose fine yet strong lines can be rapidly spun at small expense all over the largest areas, and with marvellous rapidity, simply because there are no earthworks; and almost the whole of the work can be performed in the workshops of the world, while but a fraction need be executed *in situ*.'

A full description of this Pioneer railway system was given lately in this hall by Mr. Rowan, of Glasgow, so I need not give details; but the cost is £1,000 per mile in working order, the carrying power 200 tons per diem each way, the construction at the rate of one mile per diem from each starting-place, and the tariff ½d. per mile to pay 20 per cent. dividend.

These lines would, doubtless, very soon be too small for their purpose; but therein lies the certainty of a good and immediate dividend, and the non-requirement of Government guarantees or subsidies. Extension is possible at a few months' notice; but double lines would not be laid side by side, but many a mile apart, and only touch at the termini.

TWELFTH ORDINARY MEETING.

Wednesday, February 27th, 1878; the Right Honourable Lord OTHO FITZGERALD in the chair.

The following candidates were proposed for election as members of the Society:—

Currey, Charles, 38, Tregunter-road, South Kensington, S.W.
Gilles, William Charles, 14 and 15, Paternoster-row, E.C.
Hawes, Colonel Herbert, East India United Service Club, 14, St. James's-square, S.W.
Remington, George, Jun., 19, Ashchurch-grove, Shepherd's-bush, W.
Walmsley, Francis Harrison (Mayor of Salford), Higher Broughton, Manchester.

The following candidates were balloted for and duly elected members of the Society:—

Browne, Rev. M. C., Kineton, Warwick.
De Opéda, Señor Don Luis, 20, Rue Tilsit, Champs Elysées, Paris.
Grafton, Frederick William, 91, Portland-street, Manchester.
Richard, Charles Adolphe, 24, Cannon-street, E.C.
Riddell, Henry B., 50, Queen's-gate, S.W.

The paper read was—

THE PAST, THE PRESENT, AND THE FUTURE OF THE RIVER THAMES.

By J. B. Redman, F.R.G.S., Memb. Inst. C.E.

Three great and pressing questions of the day, viz., water supply, sewage disposal, and prevention of floods, both tidal and up-country, are involved in considering the Thames, and little apology is perhaps needed for introducing the subject before this Society. As regards the river itself, the due regulation of its channel, the effect embankments may have on its hydraulic condition, and the development of the tide upwards as contradistinguished from the extension of lockage downwards, illustrated by the struggle for forming a lock at Isleworth below Richmond, are perhaps even more important.

The vast increase of traffic and small relief afforded had been one of the crying evils of the day; reports on metropolitan improvements teem with proposals for ameliorating a state of things that had become, from the loss of time involved, more and more intolerable. This was especially felt in the main thoroughfare from Charing-cross to the Bank. Plans from the time of Sir Christopher Wren, after the fire of London, to the present day, have been advocated, and, as something towards the solution of the difficulty, a river road raised on a Thames embankment, to form a collateral channel of traffic to that of the Strand, had for many years its advocates, as proposed by J. Gwynne in 1766, and Sir Frederick Eden in 1798.* The desire to palliate the evil induced the leading railway companies having metropolitan termini to push their works more and more towards the heart of the metropolis, and the numerous lines completed, in progress, or still proposed, all tend towards one common focus, and endeavour by relieving the streets to obviate one common difficulty. The Metropolitan and District Railway, or Inner Circle, about to be completed, tends to the same end. Lord Palmerston, in 1825, during the debate on Colonel Trench's plan, wittily compared the perils of a journey in a carriage from the west to the eastern part of the metropolis to the confusion which followed the battle of Leipzic.

The Embankments now completed on the north side from Chelsea to Blackfriars, and from Vauxhall to Westminster on the south side, afford relief, and at the same time very materially increase the embellishment of the metropolis; they take the lines laid down in 1840. The Embankment Commissioners' Report of 1861 significantly stated—

> "If at any future time any effect should be produced on the river from the diminution of its capacity for tidal water by reason of the embankment, arrangements may be made higher up the river by dredging, or by a tidal reservoir, to compensate for the loss. The consideration, however, of this matter would naturally devolve on the Conservators of the River Thames."

They said they were not prepared to recommend a Surrey embankment, but that the work on the Middlesex side would not interfere in any way with its being carried out—a proposition transparent enough. The difficulty is dealing with trade interests, which almost entirely engross the frontage. The question arises, are mud banks to be perpetuated for trade purposes, and whether the time has not arrived for modifying the system of mooring tiers of lighters in front of the wharves to take the ground as at present?

The well-being of the River Thames, the great artery of British commerce, is necessarily interesting; that such a feeling has long predominated is shown by the numerous plans discussed during the last half century. Works that will regulate the breadth, increase the scour and depth, promote an increased range and duration of tide, are assisting this great natural agent.

The progress of a river has been compared by Pliny to the life of man, and Denham's well-known lines on the Thames contain a similar thought.

The river from its rise at Thames Head, near Cirencester, in Gloucestershire, at a level of 376 feet above the sea, as reported before Mr. Coope's

* A plan in Sir Frederick Eden's pamphlet, "Portobello," of 1798, contains lines for the Thames Embankment to Blackfriars, New Oxford-street, the Holborn Viaduct, the new street from St. Martin's through Seven Dials northward, &c., almost identical with the improvements effected or proposed at the present time.

Committee on Thames Floods last Session, and according to the Rivers' Pollution Commissioners 340 feet above Ordnance datum, with an average fall of 2 feet per mile, has been named the Isis until its junction with the Tame or Thame fifteen miles below Oxford. The drainage area above Oxford is about 600 square miles, and a rainfall of 2 feet 6 inches would yield an average daily outflow of 716,057,280 gallons. The actual result, as observed at Wolvercot and Wytham, according to Phillips, ranges from 105,480,000 gallons, the daily dry weather summer flow, to 638,964,000 gallons, the daily yield during floods. The area of the catchment basin of the lower river above the tide, of 3,676 square miles, yields 4,000,000 gallons as daily outflow, and the maximum has been variously estimated at from 3,600,000,000 to 5,400,000,000 gallons daily discharge; but Professor Unwin, of Coopers'-hill College, obtained in October, 1875, as high a result as 7,610,760,000 gallons daily discharge through the Albert-bridge, Windsor Home Park, with a surface velocity of 5½ miles per hour. This would be nineteen times the ordinary outflow, giving some notion of the vast volume of exceptional floods: and the maximum discharge at Kingston by the Water Supply Commissioners' report of 1869 occurred in 1866, and amounted to 8,000,000,000 gallons daily. The outflow per diem per square mile in dry summer weather is equivalent to 175,000 gallons for the upper district, and 112,500 gallons per square mile for the lower district.

As regards the upper river, Mr. Taunton, the engineer of the Thames and Severn Canal, has ascertained by gaugings that the maximum flood flow at Lichlade is 28 times its summer flow, or about 576,000,000 gallons per diem; and that to carry this off with a flood fall of 2 feet per mile, would involve a section for the river only 70 feet wide at the surface, 50 feet at the bottom, and 5 feet deep, with a mean velocity of 205 feet per minute, or 2⅓ miles per hour. The level of high water at London-bridge is four feet higher than at Sheerness, a length of 48 miles, and 1 foot lower than at Richmond, a distance of 16½ miles, and 1½ miles below Teddington, where the first weir is situate, and which in effect is the termination of the tidal range (save under recent exceptional conditions), and where high water at spring tides is ordinarily two feet higher than at London-bridge.

It cannot be too forcibly urged that the embankment of the Thames is no mere architectural question, one only of pictorial effect and embellishment, or even alone of affording accommodation to the traffic and trade of the metropolis, but that it is a work regulating one of the most powerful natural agents, a great river, whose facilities for commerce may be immensely developed, but that its natural conditions demand the greatest possible caution to avoid aught antagonistic to its welfare; and no schemes within the tidal range that cannot be fully and entirely reconciled with measures necessary for the maintenance, nay, for the progressive development and improvement of the river, which possesses a great and variable oscillation of tide, subject to no ordinary fluctuations, can be thought of for one moment.

To enforce these considerations it is only necessary to glance at the days when the estuary probably extended above London, and to the various works by which this natural condition has been altered or modified. The very name of London has been considered typical, anciently, "Llyn-Din," or town on the lake. As Cruden says in his history of Gravesend and the port of London, "the primeval condition of the river as drawn by Sir Christopher Wren will reflect the picture that readily occurs to the imagination." We find on this subject in the *Parentalia*, that "the surveyor was of opinion that the whole country between Camberwell-hill and the hills of Essex might have been a great frith or sinus of the sea, and much wider near the mouth of the Thames, which made a large plain of sand at low water, through which the river found its way." Cæsar calls it "Alma," and it was crossed by him to attack Cassivellannus. Doomsday Book refers to its navigation and locks. Magna Charta contained provisions for the removal of weirs and obstructions. Edicts for its regulation were issued by King John. Queen Elizabeth forbade cutting of wood, at first within fourteen, and subsequently within twenty-two miles of the river. Dupin commends the Act of 21st of James I., for rendering the Thames navigable from London to Oxford, as worthy the utmost attention. He also says, "in the years 1661-62 the House of Peers attempted, but in vain, to introduce a general Act for rendering navigable all currents of water capable of answering the purposes of navigation." And he directs attention to the fact that "the basin of the Thames occupies more than the eleventh part of the territory of England and Scotland united; and on this eleventh part of its territory is accumulated the fifth of the British population."

The report of the Committee of the House of Commons of the 17th of May, 1793, concludes by referring to a controversy of twenty years' standing respecting proper measures to be enforced, as very detrimental to the public interest; and the practice of "flashing" was characterised as "the infancy of artificial navigation;" yet as recently as May, 1865, evidence was given before a Committee of the House of Commons as to the necessity of some check on "flashing," or drawing water from the weir to float the cargoes; and the practice is designated by the Commissioners on the Pollution of Rivers in their report of March, 1866, as "antiquated, rude, and destructive to the channel banks." The old lock dues were complained of, professedly raised to keep the water back and help craft down. These inquiries led ultimately to the appointment of the present Conservancy Board, by which the management of the river from its source to the sea was consolidated.

The first bridge of timber at London, was built in the reign of King Ethelred, 993-1016, and in the last year Canute is said to have constructed a canal through the marshes south of the Thames, to convey his ships to the westward of the bridge, when he besieged London; the site is conjectural —some have placed it between Rotherhithe and Chelsea Reach. The bridge was destroyed in 1136 by fire, but repaired. In 1163 it was so ruinous that Peter of Colechurch commenced the stone bridge; he was prevented by death or infirmity from completing his task, and one Isenbert was recommended by King John to the Mayor and citizens, in the third year of his reign, who appear to have been independent enough to make their

own selection, notwithstanding the royal testimonial, as the bridge was completed in 1209, under the supervision of Serle Mercer, William Almaine, and Benedict Botewrite, citizens.

In 1280, seventy years after its completion, it was so ruinous that Edward I. granted his license to solicit charitable contributions. These proving insufficient, letters patent were granted the following year for taking toll. The decay arose mainly from a fire in Southwark, which spread along the bridge, and, in 1282, a severe frost and snow produced such ice and floods, that five arches were destroyed. In 1426, the draw-bridge and tower for defence was erected; in 1582, the water works were constructed by Peter Morrice, a Dutchman; in 1632 another fire destroyed 42 of the houses that had been erected on the bridge; a number of them were rebuilt in 1645-46; and, in 1666, the great fire destroyed all the houses, and materially damaged the stonework. The houses were again rebuilt. As early as 1722, the Lord Mayor published an order to preserve a clear passage over, and appointed three persons to see it carried out, one from Christ's Hospital, another from the inhabitants of the Ward of Bridge Within, and the third representing the bridge-master. By this order those coming out of the City were directed to keep on the east side, and those out of Southwark on the west side. In 1730 a survey was made, when it appeared the foundations were huge piles of timber driven close together, covered with a timber flooring ten inches thick, on which the stone piers rested, three feet below the starlings, and nine feet above the bed of the river. In 1746, it was resolved to remove all the houses, to increase the roadway space; in 1756, an Act was applied for, for this purpose; in 1757 a temporary bridge was erected over the west starlings for the traffic during the operations; this was burnt down just after the removal of the houses in 1758; the bridge was, however, re-opened in a fortnight, a new temporary bridge constructed, and the great arch subsequently formed.

Great changes have resulted from the removal of Old London, Blackfriars, and Westminster-bridges. The effect is that whereas, in 1720, the flood tide during spring commenced 3 hours and 50 minutes before high water, now, at London-bridge, it commences to rise $5\frac{1}{4}$ hours before high water, equal 1 hour and 25 minutes' gain, or earlier tide; the time of high water has also been accelerated, from 1213 to 1683 it was reckoned three hours after the moon's transit, now two hours after; in 1830 high water was one hour and three-quarters after Sheerness, now it is only one hour and a quarter later; equal a gain of half an hour in fifty-six years, due mainly to the removal of old London-bridge, by which the transverse sectional area at high water was increased from 7,300 to 17,600 square feet. Low water has been lowered all the way from London-bridge to Teddington-lock; four feet at London-bridge, three feet six inches at Westminster, two feet six inches at Battersea, and two feet at Teddington. The normal high water below London-bridge is practically unaltered, but it is raised one foot at Battersea, this added to the depression of low water, gives an increased range of three feet six inches. The current has been increased, and the same quantity that formerly flowed over Teddington Weir, now flows through a smaller channel, the result is, a lowering of the river bed. The tidal range, and quantity of tidal water flowing between London-bridge and and Teddington, is increased by more than one-fourth part, and all this is added to the scouring power below, and has produced a corresponding progressive improvement of the port of London, aided by a systematic dredging of shoals.

The failure of the foundations of old Westminster and Blackfriars bridges resulted from the lowering of the river bed, which at the last-named bridge, at the time of its failure, was from six to ten feet lower than when the repairs were finished, about thirty years back. Old London-bridge acted as a regulating weir, and kept the bed of the river up to the old level above bridge, and this being assumed as a constant quantity by the designers of the metropolitan bridges, an entirely altered state of things brought about the results we now see.

At the old Westminster-bridge, Labelye first used in the Thames caissons for founding the piers, in which were floated out the first courses of masonry, the bottoms, when the sides were disengaged, forming the platforms for the foundation courses, a level area having previously been dredged for them. This naturally induced a superficial foundation, but was a manifest improvement on the plan of building up to low water by means of "starlings," as used at old London-bridge and others of that period, where the piers were built on platforms supported on piles, and the area surrounded by bulwarks of timber filled in with stone, which so much contracted the waterway. Vauxhall-bridge piers were also founded by caissons, and those of Blackfriars-bridge by Mylne, but in the latter case on bearing piles; London, Southwark, and Waterloo-bridges, by Rennie, are supported by bearing piles with platforms, on which rest the piers, founded with the aid of temporary cofferdams, for the exclusion of water around them. The piles, where only driven in the upper stratum of sand and gravel, are readily undermined as the bed descends, and when, in London-clay, the latter squeezes up around the piers, when relieved of the superincumbent mass of gravel; this is obviated by the modern appliances of cylinders and cast-iron sheet piling, and where bearing piles are used, by the driving of them much deeper than heretofore into the London-clay sub-stratum. In illustration, the cylinders of the Royal-terrace-pier, Gravesend, those of new Rochester-bridge, and the Charing-cross and Cannon-street railway bridges, the cast-iron casing of Battersea suspension and Westminster-bridges, the cylinders of the Blackfriars railway bridge, and wrought iron caissons of Blackfriars-bridge, may be mentioned.

There is no direct testimony regarding the original formation of the embankments of the lower reaches. Sir Christopher Wren, in the *Parentalia*, suggested that the foreshores left on the recession of the tide were gradually raised by natural agencies; this view being borne out, he thought, by the strata along the shores, and the existence at certain depths of beds of shells; he thought that the work of embanking the Thames was too great and difficult for the ancient Britons, that the Saxons were too much engaged in their continental wars to attempt it, and he was of

opinion, like Dugdale, that the Romans were the authors of this great work; the latter author suggested that neither the Britons or Saxons were sufficiently advanced for it.

The importance of maintaining efficiently the river banks, upheld by Commissioners of Sewers appointed under statutes of Henry VIII., for the sewage of lands and conservancy of the river walls, has been shown on numerous occasions by breaches occurring in the latter, cases of which are cited by Dugdale, more especially that of Hornchurch. The more modern one of Daggenham is well known, eventually stopped by the genius of Perry, after the levels had remained flooded for many years, to the destruction of land and deterioration of navigation; evidences of both of which we now have in Daggenham-lake, some 40 feet in depth below the level of low water, and in the river in Daggenham Hole and Shoal, formerly well known to pilots, the last now nearly removed by dredging; in the former there was 30 feet at low water close up to the foreshore.

Long before Perry's time, Sir Charles Vermuyden, the well-known Dutch engineer, came over to this country during the reign of James I., who was the author of several of the embankments of the lower reaches.

These parallel embankments, by narrowing and confining the channel at high water, form an aqueduct, as the water is then six or seven feet above the marsh surface, which, during the great tide of November, 1875, would have been nearly twelve feet below high water.

The trade of the port of London could never have increased as it has but for the regulation of the channel, and the increased flow of tidal water produced by the early works of embankment; similar results have developed at Glasgow, from the more modern works on the Clyde of a similar character.

This increase is almost eclipsed by that of Liverpool, due to greater range of tide, more rapid development of dock enterprise, earlier connection with the railway system, and propinquity to centres of manufacture.

In 1660, the Legal Quay, 1,400 feet in length, below London-bridge, was the only accommodation for landing foreign produce; in 1795-6, the crowded state of the river caused an inquiry before the House of Commons. The report of May, 1796, showed that in seventy years trade had nearly doubled, and in the quarter of a century following the increase was proportionate; towards the end of the century the foreign import and export values were trebled, the import tonnage quadrupled, and the export more than quintupled.

The coasting trade, colliers forming more than one-half, increased correspondingly, imports nearly quintupled, and exports more than quadrupled.

In this century the dimensions of British shipping and the number of total entries were doubled: attention was then directed to the necessity of removing the foreign trade, either into docks, or lower down the river, as the same necessity has been entailed of late years with colliers.

The objections urged to docking ships conveying timber, now (but only recently) universally so accommodated, raises the question of the reasonableness of the opposition in the coal trade to such a proceeding. This trade is now, however, conducted almost entirely by steam vessels, and the old collier is becoming extinct. The river was shown to be ill-adapted for a dock, and the practice of mooring tiers of vessels in the navigable channel was characterised in terms equally appropriate now.

In the first report of 1799, regret was expressed that no steps had been taken, and it urged the advantages experienced by the outports from wet docks, and recommended the immediate execution of the Isle of Dogs and Wapping plans; a succeeding report of July, 1799, classified the various projects, without any recommendation. The Select Committee of July, 1800, referred to the Wapping (London Dock) plan, passed that Session, which provided for the purchase of the Legal Quays, also to the Act passed in the prior Session for the West India Docks. It is, the Committee says, "with great satisfaction they point out these vast and expensive enterprises, as undeniable proofs of the spirit, the activity, and wealth of the nation."

In the year 1800, the London and West India Docks were commenced, and in 1803 the East India Docks. The Surrey Canal Dock, and the Commercial Docks, on the opposite side of the river, were subsequently formed.

In 1796, a navigable channel of 250 ft. had been insisted on by the Legislature, when 11,000 ships entered in a twelvemonth.

In 1824-5, notwithstanding the construction of the above docks, the crowded state of the river, and the urgent necessity of increasing dock room, again engaged the attention of the Legislature, when Acts were passed for Collier Docks, South London Docks, and the St. Katharine Docks; the two former were, however, never made. In 1828, when the St. Katharine Docks were opened, the number of ships entering had increased to 23,000, or more than double those towards the end of the former century. A port regulation was then made to preserve a clear 300 ft. channel, legally confirmed in 1829; in 1831, a Committee of the House of Commons reported on the necessity of enforcing this regulation; in 1832, representations were made by many influential bodies on the crowded state of the river; in 1833, stringent orders were issued by the Port Committee to enforce the 300 ft. channel, and, in December of the same year, after a most laborious investigation, this width was adhered to; in 1834, a report was made embodying this decision. In 1835, the number of ships entering had reached 25,365, denoting a much higher rate of increase; in this year the preservation of the channel was urged upon the attention of the Port Committee, by memorials from the St. Katharine Docks Company and others. In the autumn of this year, so great was the excitement caused by an alleged proposed reduction of the channel back to 250 feet, that papers were circulated, in which it was urged that, the Legislature having sanctioned the expenditure of £6,000,000 or £7,000,000 on the London Docks, St. Katharine Docks, and Grand Surrey Canal Docks, it was incumbent on the authorities to preserve free access, recommending, at the same time, the preservation of the 300 feet channel, and certain dispositions of the tiers by fixed moorings. In 1836, so great were the impediments, that a Select Committee of the House of Commons sat on the subject, the recommendations of which were similar; in the appendix

to their report, the well-known harbour-master, Capt. Fisher, in a letter, said he saw no remedy but compelling the colliers to go into a dock, and urged the advantages of a depôt in equalising prices.

From 1830 to 1837, various plans for collier docks were proposed, to which there existed as great a prejudice as formerly in the case of general produce and timber, probably as well founded; the unloading at less cost than by the rude and primitive method formerly employed in the river, the greater despatch and security from danger, were all features urged in their favour. The coal trade is now, however, entirely altered; the sea-borne tonnage is a decreasing quantity, railways bringing in the main portion, and the sea-borne coals are now very rapidly transferred, by floating machinery in Blackwall and Woolwich reaches, to lighters towed up stream in fleets by steam tugs.

The foreign imports and exports were in a still increasing ratio for the first half of the present century. This applied also to the coasting trade; the foreign export tonnage had more than doubled, the import trebled, and the coasting trade much more so; the development of steam tonnage was even more remarkable. Mr. Hume, as examining tidal harbour commissioner for 1846, referred to Mr. Rowland, the harbour master, as, after four years additional experience, recommending the removal of the seven sections of laden colliers, which were berthed in the deepest part of the river, and to his strongly urging that docks should be erected for their reception; in this opinion Mr. Hume concurred, and the Commission generally. They said, "the increase of steam navigation rendering necessary the widening and deepening the waterway."

To meet this, the collier tiers were re-arranged, moored in the lower reaches, and only allowed to come up into the Pool in certain gradation.

The dock acreage of London, instead of keeping pace with the wonderful increase of freightage, had, before the opening of the Victoria Docks, with very slight addition, been absolutely stationary for a quarter of a century, and the two hundred acres of dock, which in 1828 supplied the wants of the crowded chief port of the world, appeared to have been long considered sufficient for its ever-increasing wants.

The existing metropolitan dock companies have felt the force of those circumstances, and the necessity for larger entrances, due to increase in the size of ships, as an expenditure of about a million had taken place in improving the accesses to the present establishments, but adding very little to the dock acreage of the port. The London Dock Company constructed a more capacious entrance, and a slight accession to their dock area; the Regent's-canal Company enlarged their dock for colliers, with machinery for quick discharge, and constructed a large ship lock; the East and West India Dock Companies formed a small two-acre basin and locks between the Blackwall basin of the West India Dock, and the City-canal or South Dock, to render the two river locks common to the establishment; the reservoir north of the Blackwall basin has also, of late years, been formed into a dock, and recently supplemented by a narrow parallel dock and lastly, the City-canal has been widened and converted into a new South Dock. A new additional large entrance lock to the East India Dock, and an enlargement of the tidal-basin, are also in progress.

The Victoria Docks in Essex, below the river Lea, now in full operation, add nearly one hundred acres to the port accommodation; and so great was the confidence of the promoters, that powers were taken for an additional 150 acres. Considering their site, these views were possibly not audaciously sanguine. The extension works to Gallion's Reach, below Woolwich, are now in course of formation by the united directorate of the London, St. Katherine, and Victoria Docks.

The Commercial Docks Company purchased and reconstructed the East Country Dock, with a new entrance and connecting locks, which gives them an additional deep water entrance lower down; also an entrance near the centre of the establishment opposite Limehouse.

The Surrey Docks, now incorporated with the Commercial, are also enlarged by two new docks and a deep water lock, admitting a much larger class of timber vessel, formerly compelled to discharge in the river.

The old companies, taking example from their younger sister, had their quays connected by rail, so that goods from the manufacturing districts come direct to the ships' side. This must eventually tell very much in their favour, but has been an established fact in Liverpool for many years.

In London, what is significantly called the "long-shore" interest, had, prior to the Victoria Dock Act, been sufficiently potent to exclude any clause for the construction of graving docks, for the building or repairing of ships, which was thought to militate to the prejudice of the private dockyards; notoriously the case with the London Dock Bill, which contained a clause for that purpose, subsequently struck out; it required half a century for a public company to obtain such powers.

Thames Haven, Gravesend, Northfleet, Daggenham, and Erith, where docks have been proposed, appear to be too low down the river to form, at least at present, immediate adjuncts to the port of London; on the other hand, from the value of property, the crowded state of the river, and its contracted width and depth, the various schemes for increasing dock room, brought forward during the last quarter of a century, have, in the majority of instances, been all too high up the river; this was forcibly shown by the rejection of the Wellington Dock Bill by a committee of the House of Commons in 1854, which proposed to form docks at Rotherhithe, near the Spa-road Station, opposite the London Docks; the committee considered that sufficient time had not been allowed for the development of the Victoria Docks, and that the projected works were too high up the river, and too near existing establishments, especially the London and St. Katherine Docks.

We have now two great companies on the north side, the London, St. Katherine, and Victoria Company, and the East and West India Company; and in addition, the Millwall Dock, recently formed in the Isle of Dogs; and lastly, one company only on the southern Surrey shore, whose docks are chiefly devoted to the timber and grain trade.

In 1816, the number of entries and clearings of foreign and British ships engaged in the foreign trade was, at Liverpool, exactly one-half the cor-

responding amount in London; the same held good as regards tonnage; but, in 1830, we have this remarkable fact, that although the number of entries and clearings held nearly the same ratio as before, the aggregate tonnage at Liverpool within 27,000, equalled that of London, showing how great had been the increase in the size of vessels engaged in the foreign trade at Liverpool as compared with London. The greater number of ocean-going steamers from Liverpool would also affect the result. Last year, the aggregate foreign tonnage of Liverpool was somewhat under nine, and of London over nine and a half millions.

In 1850, three and a half millions of sea-borne coals were brought into London, compared with eighty-four thousand by canal and railway; in 1871, only two and three quarter million of sea-borne, as compared with nearly four and a half million inland; showing, that although the sea-borne coal has greatly diminished, there is an enormous increase by land, mainly by railway.

These tonnage results denote how much constantly increasing accommodation is required, but to say that the river improvements cannot be very greatly extended would be to take a narrow view. The dredging engine is the requisite agent, and doubtless the tide will maintain a much deeper channel than the minimum water over still existing shoals. This work is being actively prosecuted, but from the fact that only such material as was saleable was dredged for formerly, a large arrear of work fell to the present authorities.

Liverpool, due to her contiguity to the chief seats of manufacture, also, in a large degree, to the spirit of enterprise characteristic of her merchants, took the initiative in constructing docks, connected them first with railways, and preceded her sister-port in lighting the lower reaches of her river, and in immensely developing her resources.

It may be said that the contiguity of Liverpool to Manchester is the whole secret of her success, still it may be asked whether the spirit of enterprise which especially distinguishes her, has not something to do with it. Englishmen are fond of their rights, and, as we shall see from old Griffiths, the Thames has been made the arena for much disputatious pretensions between Kings, Archbishops, Lord High Admirals, Lord Mayors, Aldermen, and Common Councilmen. It was the proud boast of the Committee of 1796 that the foreign tonnage and size of her ships had been doubled in the port of London in a century. Could it be a similar boast of a Committee, sitting at the end of the nineteenth century, that London had done all in her power for the development of her wonderful natural facilities? Possessing only the small Greenland Dock in Rotherhithe, and Perry's still smaller dock at Blackwall, in 1796, she has ever taken a contracted view of her interests, for it was only when compelled by overpowering circumstances, in the crowded state of her river, and the losses her merchants sustained, when their vessels lay out in the stream in tiers, that, after hard fights, London consented to imitate Liverpool, though she would not do so in allowing graving docks to be formed in public establishments; such an attempt has, during the present century, up to within a very short period, been frustrated. It is to be hoped, with a Conservancy Board representing the interests that formerly struggled for exclusive rights, that what is so great a desideratum, namely, an equable and duly increasing low-water channel from Teddington to Gravesend, if not above the former place, may be obtained. When it is considered that from Gravesend to Purfleet there is a general depth of from forty to thirty feet at low water, thence to below Daggenham thirty to twenty feet, above to Woolwich twenty to fifteen feet, and upwards generally ten feet to London-bridge, it appears an anomaly that shoals, up to within a comparatively recent period, should have been allowed to encumber the navigation, and check the upward tidal wave, that would otherwise tend to maintain a deeper channel by its more free advent.

Whilst the origin of the embankments of the lower reaches is involved in obscurity, the condition of the upper reaches, hemmed in by the increasing metropolis, had been very little improved, notwithstanding the multitude of suggestions to ameliorate a state of things that had become, from the number of questions involved, more and more difficult to deal with each succeeding year. Great changes resulted from the removal of old London-bridge, which, for more than six centuries, formed a partial weir, altering the natural condition above, locking up the water, and allowing only a certain amount to run off at low water, when at neaps there was a fall of water of two feet, and at springs of four feet four inches, which, during floods with a low spring ebb, amounted to six feet. We had a striking record of this in a depth of thirty-six feet at low water below the site of the old bridge; the resultant of this waterfall now diminished by deposit to fifteen feet. At high water of neap tides the difference in level above and below the bridge was not perceptible, but during springs the water flowed vertically eight inches higher below the bridge than above. The resultant effects from the removal of old London-bridge were that littoral mud-banks before drying slightly were exposed, and that there is now a freer tidal range above bridge, and consequent great scour.

The capacity of the river for commerce is illustrated by the tidal range; it forms the great outfall for the rainfall from the London basin and the metropolitan area; thirdly, it mainly supplies London with water; and, lastly, abused and overtasked as it is, in addition to proving the source of the wealth of the metropolis, it also forms its chief ornament, and, from the tidal oscillation, its great sanitary agent.

Gwynn, in 1766, in his "London and Westminster Improved," speaks thus of the river banks of his day, not inappropriate to portions of the river of our time:—"A city of trade and commerce, situated on the banks of so noble a river as the Thames; the wharfs and quays on its banks are despicable and inconvenient beyond conception, and it is utterly impossible that a worse use could have been made of so beneficial, as well as ornamental, a part of this city."

The other altered condition of the river was, that what under the old statutes of sewers was illegal, consequent on the introduction of a more plentiful water supply, and modern appliances, became legalised; the cesspool had been abolished, the night-cart and lay-stall became extinct within the urban boundary, and the sewers, originally only laid out to carry off the rainfall, had become

extended in their ramifications as well as uses. The river had become the general recipient or open cesspool, and the results, as evolved by the high temperature of the summer and autumn of 1858, were only too patent. Gas, usually latent, escaped under this atmospheric condition, had free range, and sufficiently testified to the polluted condition of the "silver" Thames; and the apparent anomaly presented itself, that at high water the stench was more overpowering than at low water, the very converse of what is usually the case. When the marginal mud-banks were most exposed the smell was least, and when covered the exhalations were most oppressive, indicating that the much-abused mud-banks had little to do with the matter, they, in effect, being mainly resultants accumulating for centuries, the active agents for evil being contained in the water, which at low water, coming from the up country, is comparatively pure, whilst the infected water, which had received the diurnal discharge of sewage, was penned back by the returning tide, and it was a common remark by the men working the steam-boats, in answer to the observation that the river appeared improved at low water, "Oh, we shall have it as bad as ever on the flood."

The pollution of the Thames by sewage led, after numerous Parliamentary inquiries, to the metropolitan water companies obtaining their supplies from higher, more distant, and purer sources; and the main drainage works on either side of the river will, it has been hoped, convey the sewage so low down as to render it innocuous as regards the metropolis. Their extension further seaward will possibly be involved hereafter, or the raw sewage will have to be dealt with by precipitation, filtration, or otherwise, before flowing into the river. This question is in itself so large, and one on which those who have devoted special attention to the subject differ so widely, that no more can be attempted now than to direct attention to the fact that the vast tracts of marshes, saltings, and estuary foreshore sands, afford ample field for the filtering or clarifying of the raw sewage before it is turned into the Thames, apart altogether from the question whether such an application may be made remunerative or not. As the towns on the upper river are to be prevented from draining into the stream, without such precautionary measures, it would appear a glaring anomaly if the metropolis were to continue to convert the great highway of the river into its *cloaca maxima*, to which result the report of Capt. Calver to the Thames Conservancy would appear to point.

Callis, in his work, "The Reading of that Famous and Learned Gentleman, Robert Callis, Esq., Serjeant-at-law, upon the Statute of Hen. VIII., cap. 5, of Sewers, as it was delivered by him at Gray's-inn in August, 1622," thus describes the sewer of his day:—"The sewer is a fresh-water trench, compassed in on both sides with a bank, and is a small current, or little river."

The sewers draining the metropolitan area were formerly presided over by commissioners acting for districts, under statutes of Henry VIII., treated of by Callis, as the marsh-lands are at the present time. The results attendant upon the reversal of the policy of our forefathers we have had; and, whereas in their time it was illegal to form house connections with sewers, it is now illegal to build a house without making provision for drainage into those very sewers which, in Callis's time, were open water-courses, subsequently arched in as buildings increased, with now the double duty forced on them of house as well as land drainage.

Griffiths recited the Act of Common Council made, in pursuance of the 27th Hen. VIII., A.D. 1538, for the preservation of the river, which, after making provision far dredging shoals and repairing the banks, provides that gratings shall be placed across water-courses flowing into the Thames, and imposes a fine for sweeping "soilage" into the channel. This Act also regulated the use of lay-stalls and dung-boats.

In illustration of the changed condition of the river, Roger Griffiths, the water-bailiff of his day, in "An Essay to Prove that the Jurisdiction and Conservancy of the River Thames, &c., is committed to the Lord Mayor and City of London, &c." (Lond., 1746), describes the object of his work as being "to set forth the beauty and value which the river of Thames is to the publick." He refers to the extent of its navigation and shipping, the nursery it forms for seamen, and that invaluable blessing we have in its fishery," and says lovingly, "it far exceeds all other rivers in the known world;" "should not," he appealingly says, "such a river be therefore preserved from all obstacles and damages that may occur either to its navigation or fishery?" Of her conservators he vauntingly says:—"The ancient guardians of this truly Imperial City have always looked upon this noble jurisdiction as one of their greatest honours, and have often shown, by enacting new orders, not only their care of this great river, but, likewise, how much they regarded so great a trust as the prosperity of its navigation and fishery." He adds that in olden time the City had resisted any encroachment on their jurisdiction, not only of private persons, but "archbishops, lord high admirals, and even with kings themselves."

The tides and any exceptional ranges or irregularities, have naturally, from a very early date, attracted attention. We find Holinshed describing them, also Stow and other old writers, and in Gough's "Topography" we find a paper that was published at the time of the occurrence, Friday, 4th Feb., 1641, called, "A Strange Wonder, or the Citie's Amazement," caused by two tides flowing at London-bridge within an hour-and-a-half. Variations in the regular flow and reflux, and the rare double tides, are caused by gales of wind; these and any extraordinary elevation of tide, on account of the disastrous effects they produced, naturally excited attention. and are matters of history. In the "Philosophical Transactions of the Royal Society," 1756, is a paper on the irregularities of the tides at Chatham, Sheerness, Woolwich, and Deptford, in February, 1756, communicated by the Right Hon. George Lord Anson, in which is shown the great variation in range, caused by a shifting of wind and gales.

The first comprehensive plan for the improvement of the banks of the metropolitan portion of the river in modern times was that by Sir Christopher Wren, after the fire of London, in 1666. In 1767 an embankment was carried out on the Middlesex shore by Mylne, in connection with Blackfriars-bridge. The well-known terrace of

Somerset-house, by Sir William Chambers; the Adelphi-terrace and embankment in 1770, by the Brothers Adam; and the Penitentiary embankment, Millbank, about complete the list of such works above bridge, until the terrace was formed for the new Houses of Parliament, the first instalment of the modern Thames Embankment.

On the 17th May, 1793, a report was made by a Committee of the House of Commons, which recites the various Acts for the improvement of the river, and the several schemes that had been brought forward from time to time, and pointedly directed attention to the fact, that no regular survey or plan of the river had ever been made, nor had any systematic scheme of improvement been acted on. This pointed criticism is almost equally apposite at the present time.

On the 13th May, 1796, a committee again reported; among others, a plan was brought forward by Mr. Ogle, for deepening and improving the river, and extending the legal quays. Evidence went to prove that this deepening could not be maintained, except at great annual charges, without a corresponding narrowing of the channel, "all rivers," the report stated, "having a tendency to restore themselves to their natural dimensions, proportional to the volume of water they may have to discharge." This, however, was prior to the removal of old London-bridge, and when the increased volume of water to be gained, was not, perhaps, altogether anticipated. In the appendix is a report from Mr. Reveley, in which he proposed to regulate the widths and depths, and he said upon the full or partial execution of his proposal did the relative improvement depend; he also recommended the removal of old London-bridge and the water works.

On the 1st June, 1799, a Select Committee of the House of Commons made their first report on the improvement of the port of London, and on the 11th July, 1799, a second report on the various projects then afloat for docks and quays, and on the rebuilding of London-bridge. Mr. Dance, the surveyor, had been called on for a plan of the old bridge, from which it appeared that, subsequent to 1761, the two centre arches had been thrown into one. From a report made by Smeaton, this caused, what might have been inferred to some extent, the tide flowing four inches higher vertically above the bridge than before the alteration. The starlings around the piers had also been strengthened, and the committee referred to the fact that the depth under the centre arch at low water was ten feet, but that a bank below it had at the same period of tide, only eighteen inches of water on it. Smeaton, in a report to this committee, compared the effect on the river to that produced by a sluice, through the openings of which the water of one part of the river was discharged into the other. Ralph Walker, also, showed that the bridge was the cause of shortening the distance the tides would flow up, and deprived the river of a natural scour below; he also considered that embankments would have a similar effect proportionate to their extent. On the 28th July, 1800, the Select Committee reported in favour of rebuilding the bridge; respecting the proposition to embank and improve the shores, an opinion was expressed that a considerable embankment of the north shore would be an improvement. A quarter of a century later, we find Nash, Col. Trench, and Martin, the painter, all advocating a Thames quay; opinions as to the effects to be expected were divided. Col. Trench brought forward his plan for an embankment and raised roadway in 1824, and published a quarto illustrated volume, dedicated to his Grace the Duke of Rutland, in 1827, wherein the Strand of that day is described by the Colonel as, "that important thoroughfare, dangerous and almost impassable." He referred to the counter proposition for a quay on the south side, which he considered would be comparatively useless in relieving the street traffic. Of his own design, he says:—"The promoters of the plan for making a quay along the north bank of the Thames do not pretend to the merit of a novel suggestion." In his repeated references to Continental cities, as an argument in his favour, the gallant Colonel, and the numerous projectors that have succeeded him, forgot how little real comparison there is between the banks of the Thames, regarded for trade purposes, and those of any other river in Europe.

On the 17th July, 1824, a meeting of influential persons, and of those connected with the river, was held on board the Merchant Taylors' state barge, to consider Colonel Trench's plan, which he described, and said that his terrace would "form one side of a basin, or wet dock, containing seven or eight acres of water." The road was proposed to be raised to the level of the bridges, on a colonnade, for which the columns then standing in the Quadrant, Regent-street, were the Colonel's favourite type, and which he measured in 1840, for the purpose. Under this viaduct was headway for the wharves and access to the docks. Messrs. Wyatt and Rennie subsequently estimated the cost of the proposed work at £611,000.

On the 26th December, 1824, the *Times* said.—"We have seen the representation of the proposed Thames Quay in the pantomime, and the only place where we are ever likely to see any more of it."

In an article in the *London Magazine* of 1st Jan., 1825, the construction of the quay on the south side was advocated, as "following the plan which nature seems to have recommended, "that at Waterloo-bridge, the principal and only navigable channel is close to the Middlesex shore, and that the three southernmost arches of this bridge could, "without reducing the bridge a fragment, be advantageously spared from the river."

Rennie, in a letter of 14th September, 1824, to the Committee of Management, stated, "It was his opinion, as far as his researches had gone, that the navigation of the river would not be injured, but improved, by the construction of a quay 100 feet wide, to extend from Scotland-yard to Waterloo-bridge, and also, that the whole expense would amount to £350,000." This, in effect, was the turning-point of the question, whether it was advisable to carry an embankment into the deep water in front of Somerset-house. Mr. Rennie, prudently at that time, stopped at Waterloo-bridge, the deep water under which is at the extreme Middlesex end. By commencing below Scotland-yard, he also avoided the then almost insuperable difficulty of passing all the ornamental property in Whitehall and Privy-gardens, and also avoided interference with the

coal trade, so much deprecated then. The good achieved by passing Somerset-house and the Temple-gardens was the extension of the river-road more eastward, towards the City.

A joint stock company was formed, called the "Thames Quay Company," for raising the funds by £100 shares, and Sir Edward Bankes offered to execute the work on Mr. Rennie's estimates and prices. In a memorial, addressed to the Lord Mayor and Common Council of the City of London, by owners and occupiers of wharves and premises on the north bank of the Thames, they stated that their property would be materially injured, and, in places, destroyed; and in a letter to the newspapers of the day, of 4th February, 1825, they reiterated their objections to the plan, and expressed their determination to oppose it by every possible and legal means in every stage, and that no modification could compensate them, if the scheme, which they termed absurd and extravagant, were carried out.

Col. Trench presented his petition on the 19th of February, 1825; during the same month his lithographed view of the north bank of the Thames, with his proposed quay and improvements, made its appearance, which drew forth very conflicting opinions and criticisms. On the 15th March he brought up the report of the committee, and moved for leave to bring in the Bill. During the debate, Mr. Calcraft referred to the interference with trade, declared the whole scheme delusive, pictorial, a splendid impossibility, and that it would cost £4,000,000 or £5,000,000 of money. Mr. Hobhouse was sorry to be obliged to confirm this view, and considered the expense of going into committee would be so great that the Colonel would never carry his plan. The result proved the truth of this prediction.

Col. Trench stated the plan applied merely to the improvement of the river. He had adopted Rennie's view respecting the terminus, and selected Craven-street to start from, on account of its altitude, and the lowness of the property to the westward.

Mr. Croker proposed postponement, until the effect of the removal of London-bridge had been ascertained. Sir J. Yorke thought the plan impracticable. Lord Palmerston considered the construction of quays would be highly advantageous. He questioned the Admiralty plea that, as the effect of rebuilding London-bridge would contract the bed of the river above at low water, the quays were objectionable; but that, were the objection that the removal of the bridge would increase the volume of water flowing upwards, and necessitate the widening of the banks, he could understand it. Sir R. Wilson supported the measure, and quoted the quay at St. Petersburgh as an example worthy of imitation. Mr. Peel trusted no decision would be come to until the effect of the removal of old London-bridge had been ascertained, and expressed a doubt whether the plan would be any improvement, that it would interfere with property, obstruct the view of the river from several places—"above all, the beautiful view from the Temple-gardens." Mr. Baring referred to the growing necessity for an improved mode of communication between the extremities of the metropolis, that the removal of the stagnant mud in front of Privy-gardens would be useful and ornamental, and was, in his opinion, indispensable. The House divided—Ayes, 85; noes, 45. Majority for bringing in the Bill, 40. Owing to the great opposition experienced, the Bill was subsequently withdrawn.

In 1840, a Committee of the House of Commons, of which the late Alderman Sir Matthew Wood, the father of the present Lord Hatherley, was chairman, went very closely into the subject. The chief plan examined was that proposed by Mr. James Walker, and a great deal of evidence was taken as to whether it could be carried out in conjunction with Colonel Trench's and Mr. Martin's prior designs. The lines suggested were for both sides of the river, starting from the abutments of Vauxhall-bridge, and joining the embankment at Millbank, the new Houses of Parliament terrace embankment, and the centre of the second Surrey arch of old Westminster-bridge; at Hungerford the piers of the Suspension-bridge defined the lines, by concerted arrangement between Messrs. Walker and Brunel; at Waterloo-bridge the first Middlesex and the second Surrey pier; at old Blackfriars-bridge the first pier on either side; at Southwark the bases of the abutment landing stairs on each side, and at London-bridge the existing wharves. These lines have been endorsed by all the authorities subsequently, and acted on, as far as Blackfriars on the Middlesex, and Westminster-bridge on the Surrey side.

This embankment was proposed for deepening the river; it was urged that the continued safety of many buildings on wharves would depend on its being carried out, owing to the deepening arising from the removal of old London-bridge; this has continued, but dredging has been more regular; these arguments were in favour of an embankment in front of Somerset-house. The estimate for the north side only was £310,000, but it was not a continuous, but intermittent wharf, and had lie-byes or recesses opposite Scotland-yard, and elsewhere, for the coal wharves, and trades requiring tiers of lighters; the sheet piling protecting the base of the quay wall was supposed to be continuous, but the wharf stopped in front of certain favoured localities, leaving an inclined plane for the barges to take the ground on, as at Calvert's brewery at the present day. There was no continuous road proposed, unless it had been carried on a viaduct, as suggested by Colonel Trench, for which supplementary designs and estimates were put in. The plan has since had numerous imitators: it was then opposed in a most vigorous, intelligent, and spirited manner, in person, by the sitting member for Lambeth, and late Under-Secretary of State for War, Sir Benjamin Hawes. The Committee, possibly from this cause, arrived at no conclusion, and, from the lateness of the Session, made no report.

On the 13th December, 1841, the same engineer, Mr. James Walker, made a report to the Thames Navigation Committee, suggesting similar lines, but extending upwards to Putney, and downwards to below Woolwich, urging that the great defect of the river was its unequal width and depth; that in few parts within the above limits was there mud below low water, but that it was nearly all on the sides, the bottom under low water being generally gravel or sand, overlying the London clay; in some places peat and silt were found above

the gravel; formerly, in many places above bridge the bottom consisted of mud where now gravel only is found. It was estimated the removal of the shoals from Erith to London-bridge, to give twelve feet at low water, and assuming that none of the material was fit for ballast, would amount to £60,000; also that the deepened channel would compensate for the backwater shut out by the embankment, and that the lowering of the surface of the water above bridge one foot, and for four miles in extent, was found by calculation to equal the solid contents of the embankments above London-bridge. It is clear, however, without calculation, that the quantity of tidal water mainly stored towards high water, is more than equivalent to an equal quantity at and near low water.

The first report of the Metropolis Improvement Commissioners of 27th January, 1844, reviewed the various plans. Whilst admitting the advantages of the solid embankment, and regulating line, they said the objections were not so easily disposed of, as "the abstraction of tidal water from a navigable river is in principle objectionable, inasmuch as it diminishes the efficiency of the scour;" and that evidence went to show that this effect, "if not felt in the Pool itself would be more or less injurious in the district of the river below the Pool." Of the evidence on this subject the report says:—"The general tendency of these opinions, indeed, in reference to the plan immediately before us, was that, assuming the navigable current to be improved by judicious dredging, and an uniform course and increased velocity to be given to its channel, the loss would in great measure be compensated; but these opinions were given in reference only to a small portion of the river, irrespectively of any system for its general management."

Mr. Page's plan of tidal docks within the embankment was brought forward to meet this objection; the dwarf piled recess and the tidal basin are both alike also an attempt to meet a difficulty, hitherto fatal to all plans alike for the metropolitan Surrey side, the affording accommodation to the trade along the banks. To docks within the embankment there are practical objections well known to all conversant with the river, the chief being, the rapid deposition of mud in any recess or lie-bye, and which, in the plan of 1840, was supposed to be raked off the inclined planes, and squeezed off by the craft taking the ground, as we see in daily operation at Calvert's wharf, just above London-bridge, and elsewhere along the river shores.

This report of 1844 contains a mass of evidence on the effects to be anticipated from the embankments, but all proposed an extensive system of dredging to remove shoals, and thus to increase the volume of water at low water, to compensate in a degree for that excluded by the embankments.

It is, however, evident, that although deepening, regulating, and improving the channel at low water is a great benefit, and and one that is being gradually secured; that the large amount of water excluded, and which formerly was available at the top of the tide for scouring below, cannot possibly be compensated for by a deepened low water above, even were it extended very much above and below the new embankments, because, to reiterate, the water is excluded at high water when most efficient for scouring below bridge, and cannot be compensated for by water stored at or towards low water, which is soon checked in its course downwards by the returning flood.

The second report of the Metropolitan Improve-Commission of 1845, referred mainly to the proposed embankments in Chelsea Reach, and contained a large body of tidal observations, illustrative of the general question, connected with those at Sheerness; as Colonel Lloyd, in 1830, levelled from the dockyard at that place to London-bridge, to establish the fact that at high water the surface is higher at the latter. The gallant officer was employed by the Lords of the Admiralty, and the results of his levelling operations were published in the "Philosophical Transactions" of the Royal Society for 1830. As regards this difference, there subsequently appeared to be somewhat contradictory evidence, or perhaps different conclusions from facts. This, possibly, arose from the averages of the tides taken at the two places. Colonel Lloyd made the difference amount to two feet at springs, which was adopted by Mr. Walker in his report of 1841; but Mr. Page, in his well-known letter to Lord Lincoln, of 1st July, 1843, showed that it really was from four to five feet. It was still, however, stated twelve years afterwards, in the discussion on Mr. Robinson's paper on the Thames, in January, 1856, at the Institution of Civil Engineers, by members who had studied the subject, that the actual difference between the levels of the tides at London-bridge and Sheerness was very small. At the time of high water in London there is a still greater difference, as at Sheerness the tide will then have fallen considerably, and the converse will be the case at the time of low water in London, as the tide will then have risen proportionately at Sheerness, and the inclination will be reversed. The water surface at Sheerness at the time of high water springs in London is eight feet lower, yielding a gradient of two inches per mile over the forty-eight miles between the two stations, the low water reversed incline being six feet, or one and a half inch per mile. There can be no doubt that really the high water difference of a fair spring tide is from four to five feet, and must have been so in 1830. This may be ascertained by anyone interested, by connecting a specific tide either at Sheerness or Harwich with an Ordnance bench mark, and referring to the same tide as marked in the journals kept at the East India and London Docks' entrances. This will be some day hereafter accurately defined, by the establishment by the authorities of self-registering tide gauges at various stations, all synchronously connected. This has been for many years a desideratum, and the want of it has been long felt by all those interested in the river.

In the tidal harbours reports of 1845, the late Mr. Hume directed attention to the then general necessity for a uniform improvement of the low water channel for navigation, and the large amount of dredging that was required to give fifteen feet at London and twenty at Barking.

On the 12th June, 1857, a Bill for the Conservancy of the Thames passed the House of Commons, promoted by the City, with the consent of the Crown, to terminate the suit so long pending between the City and Woods and Forests respecting the title to the shores, the former arguing that it had been conferred by royal charters; the latter, that it was a prescriptive right of the Crown; and

the Admiralty were also interested, as Blackstone lays it down that the title to all lands over which the tide ebbs and flows, is one of the royal prerogatives, and vested in the Lord High Admiral. The Trinity Corporation, under their charter of Henry VIII., had also certain ballastage rights. Under this Bill, since become law, the conservancy of the river is transferred to a commission, representing the Corporation of London, the Government, the Admiralty, the Board of Trade, the Trinity-house, and other local interests. Several important improvements have already been effected, but the revenue has hitherto not been large. Teddington-lock has been rebuilt of ampler dimensions and increased depth, the shoals in the Pool and downwards are being systematically dredged, to give a uniform depth at low water, increasing downwards. New and commodious landing piers have been erected at most of the chief points of resort by the steamboats, and the defective locks and weirs of the upper river are also being gradually repaired or rebuilt, and the sills lowered, increasing the drainage and navigable powers of the stream.

The Committee of the House of Commons, of 1860, received plans, partaking of the character of those of 1840 and 1844. They were again submitted to the Embankment Commission of 1861, with numerous others, some of which committed the fatal error of projecting still further into the river at Somerset-house. The whole of these designs the Commission ignored, and suggested a modified plan of their own, shutting out entirely the coal trade from Westminster-bridge to the Temple-gardens. The metropolis was now fed, they averred, by modern appliances at the various railways, and public convenience did not demand the trade in this locality. All the plans hitherto, Col. Trench's with his dock, Mr. Walker with his dwarf piled recesses, and most of their successors, had considered the affording facility to this trade, a first necessity and feature of their plans. When, however. the trade interests were purchased, this ceased. The question arises, how far is the argument applicable to certain trades on the Lambeth shore, now standing in the way of the full completion of this public improvement?

Fifty-eight plans were brought before the Commission; of them, only nine specified the height, the vital point of any design; two, with prophetic vision, proposed five feet above Trinity standard, three suggested four feet, two named three feet, and two a height of two feet; any height under four feet six inches to five feet being totally inadmissable, otherwise the entire area would have been subject to periodical inundation by high tides, now obtaining a maximum range of 4 feet 9 inches above Trinity standard in the upper reaches; the plan specially commended by the Commission itself was only 3 feet above Trinity. These plans, in some cases, proposed an embankment on each side; in others, on the Middlesex side only. One comprehensive design included both banks, from Chelsea to the estuary, with an average intervening width of 800 feet. Others extended from Westminster to London-bridge, Westminster to Queenhithe, from Whitehall to Blackfriars-bridge; some to Southwark. One gentleman proposed a new river from Deptford to Vauxhall, and to preserve the existing course as a fresh water lake. One design went down as far as the Custom-house. Twenty-seven, or nearly one-half of the designs, proposed docks, canals, or lie-byes, between the old wharf lines and the embankment, showing that to be the prevailing idea, although set aside by the Commission. A few others suggested dwarf piled recesses, as had been proposed in 1840, with a roadway over on columns, or piles. One design proposed a dam across the river, below London-bridge. Another bolder projector suggested one at Woolwich, with locks for the ships to pass through. What would the merchants on 'Change say to this novel proposition?

The projection of these embankments was very variable. Out of 26 that could be so defined, 11 took one arch of Waterloo-bridge on the Middlesex side, whilst fifteen occupied the space of two arches, or somewhat under; this was as material as the height above high water, and there appeared as great a diversity of opinion; a large number included a low level sewer, the crown of the arch of which limited very materially the available water for the docks. Some included designs for railways or tramways, and the majority had a carriage road on the high level supported on columns, or on the wharf level passing under the bridges. The estimated cost varied from £250,000 to £2,500,000.

The objection to this report is, that no conclusion was arrived at as the probable effect on the river by the projection of the embankment, and the suggestion that compensating reservoirs might be found necessary, and leaving this grave consideration to the Conservancy Commission, shows plainly the doubt then existing as to the real effect to be anticipated.

The mere consideration of the area that would be required, at least fifty acres, shows the impossibility of ever meeting the difficulty in that way; this would have to be doubled, if the Surrey embankment be also constructed; these reservoirs, away from the influence of tide, would quickly silt up, and prove the source of constant expense, if it were ever attempted to work them.

As regard the enormous accumulation of mud formerly to be seen in front of Hungerford-market and the Adelphi, anyone who then took the trouble to walk down the waterman's causeway from Privy-gardens (Whitehall-stairs) would have seen that that erection and others of a similar character, promoted the deposit and retention of silt, acting in a degree in the same way as the rectilinear jetties formerly constructed along the shores of the Clyde for the express purpose of promoting deposit; the same results may be seen at Gravesend, caused by the Customs' jetties below that town, which have been raised and lengthened from time to time, as the mud extended in range and increased in altitude. New Tavern-bridge adjoining the Ordnance jetty, was formerly used for embarking and disembarking troops; it was in 1779-1780, seven feet above the surface, and is now as much below it, and one or two successors have been built at higher levels. Mr. Reveley, in 1795, in his report, pointed out the objections to these jetties or causeways.

The fallacy of comparing the Thames with various continental rivers is obvious, nor are we in these comparisons reminded of the inundations to which the continental system of quays has

assisted in giving rise which produced an able paper from the late Emperor of France, dated from Plombières, 19th July, 1856, addressed to M. Rouher, the Minister of Public Works, in which the Emperor said, "nothing can be more easy than to construct works of art which would temporarily preserve from such inundations cities such as Lyons, Valence, Avignon, Tarascon, Orleans, Blois, and Tours. But as to a general system to be adopted in order to protect for the future from such terrible scourges our rich valleys traversed by large rivers, that is still wanting, and must be absolutely and immediately found." He afterwards said:—"The system of dykes is only a palliative, ruinous for the State, and imperfect for the interests to be protected; for, in general, the sand which is brought down constantly elevating the bed of the rivers, and the dykes tending to narrow them, it is necesary to be adding constantly to the height of these dykes, to be prolonging them along both banks, and to subject them to a constant superintendence. He attributed those sudden inundations to mountain floods; and proposed to retard the running off of the water, by the erection, on all tributary streams, at the mouths of valleys, of regulating weirs, to form reservoirs, which would only empty themselves slowly; referred to nature's work, in this respect, on a large scale, in the lakes of Constance and Geneva, as regulators to the Rhine and the Rhone; quoted the dyke of Pinay as an artificial example on a large scale, and that of La Roche, and advocated their multiplication. The Emperor's letter shows the advantage the Thames possesses as a tidal river over mountain ones, as the action of the sea tends constantly to negative the silting up of the channel, and these continental examples are not analogous to the Thames; but the results of floods have undoubtedly, at Lyons and elsewhere, been intensified by the contraction of the natural channel by quays; it is not assumed that any embankment of the Thames hitherto proposed, or partially executed, would produce any similar results; but the very modified proposition at the time, put forward by the Royal Commission on the question, with the suggestion that tidal reservoirs might be necessary for compensation, showed how alive they were to any interference with nature without affording a due equivalent. On the continent the rivers which have suffered mainly from a wholesale system of quayage in seasons of inundation, the effects of which are usually altogether ignored in making those comparisons, are not tidal, except on a small proportion of their course; and their physical features are altogether different to those of the Thames.

In conclusion, attention is directed to what the river appears really to require, viz., a systematic system of dredging from Cricklade to Teddington, also the enlargement of the tumbling bays, and lengthening of the weirs, to make the channel of carrying capacity to deliver the floods independent of lateral embankments or storage reservoirs; deepening also from Teddington to London-bridge. Within these limits for 150 miles of river, assuming the mean width to be deepened at 60 feet, and the average depth three feet, five and a quarter million of cubic yards of dredging would be involved, which, at 6d. per cubic yard, would amount to £131,250. A large amount would be usable for re-metalling the towing-paths, widening the banks where necessary, and would be available for improving riparian roads and highways, or be readily saleable; a sum of £188,750 for rebuilding the older locks, enlarging the weirs and tumbling bays, and for new sluices, would raise the amount to a quarter of a million sterling, for which the river might possibly be put into an efficient flood delivering condition, without having recourse to embankments or storage reservoirs. The application of the system adopted for the tidal portion to the upper river would be erroneous and retrogressive; it is not necessary that the banks should be raised, but that the bed should be lowered between Westminster and Waterloo or Blackfriars-bridges, as may be determined; the completion of the embankment on the Surrey shore, with increasing intervening widths downwards—the erection of an embankment on the Middlesex shore alone does not get rid of one of the chief blots on the metropolitan channel, the shoal point stretching into the river at Waterloo-bridge; also a systematic dredging of the shoals, partly accomplished, to obtain a regularly increasing depth at low water; the enlarged sectional area thus obtained to form a compensation in a degree for the amount of tidal water excluded at high water, as the increased depth of the low water *régime* raises the height of high water, thus affording compensation. If this deepening were carried up to Teddington, such an increased range of tide might be obtained there, that ultimately Teddington-lock might be removed, and the reach above connected with the tidal portion of the river; a compensation fully equal to the obstruction that might be caused by any embankment works hitherto proposed, might be ultimately thus obtained, and that great desideration, the increased commercial capacity of the river, be immensely developed.

It appears to me the increased low-water channel upwards would be more useful than any compensation reservoirs, constructed for the reception and storage of tidal water as an equivalent, the ultimate action of which would be very doubtful, and examples might be quoted where such reservoirs in the neighbourhood of London, constructed for a similar purpose, on the river Lea, were practically a dead letter, unused, rapidly mudded up, and abandoned under the last Navigation Act.

If the Middlesex shore be alone embanked, leaving that on the Surrey side to futurity, the benefits that might arise from the matured and comprehensive measure of James Walker in 1840, may be lost, and the low lying properties on the Surrey side, now subject to periodical inundation, would remain in the same hazardous position, in the event of continued or even increased exceptional ranges of tide, which may certainly be looked for. Lord Palmerston appeared fully alive to this, as he gave a conditional assent that any embankment plan should include both sides.

That this is no fancied objection, a review of the altered condition of the metropolitan portion of the river will show.

The normal height of high water throughout the year in the port of London is constant, but abnormal tides now rise exceptionally higher compared with those half a century back.

On the 18th October, 1841, the tide rose 3 feet 6 inches above Trinity standard of high water spring

tides; it was considered by some the highest recorded for half a century; one, however, occurred on the 29th January, 1834, of the same height; on the 12th November, 1852, 3 feet 7 inches above Trinity was attained; the land flood of that year is popularly known as the Duke of Wellington's flood, from the demise of the great captain at that period. No such tide recurred for nearly seventeen years, until March, 1869, when a similar height was again reached, and this was about the period of the completion of the Thames Embankments. Five years afterwards, on the 20th March, 1874, the tide rose nine inches higher than ever before recorded, viz., to 4 ft. 4 in.; and on the 15th November, 1875, five inches still higher, attaining the extraordinary height of 4 ft. 9 in. in the upper reaches; on the 2nd January, 1877, the same height was attained as in March, 1874; on the 31st January, 1877, 3 ft. 7 in. was registered; and on the 8th October last 3 ft. 6 in. to 3 ft. 9 in., with a strong NNW. wind.

These excessive abnormal metropolitan tides, which rise no higher at Sheerness than forty years back, arise from the almost accidental (as they cannot be predicated) concurrence of three causes, an exceptionally heavy land flood, meeting an equinoctial spring tide, accompanied by a great westerly gale heaping up the Channel sea, suddenly veering to North-West, and driving the accelerated tidal wave before it from the North Sea up the Thames estuary, the result being, that a superimposed wind wave, on the crest of the tidal wave, the last of which is due to astronomical influences, meets a head of land-water resultant on exceptional meteorological conditions, producing excessive rainfall.

Four reasons may be assigned for the accentuation of modern exceptional tides, variable in their proportion, and, difficult to estimate with existing data; they are, the increased rate of discharge of winter floods from the catchment basin, due, it is assumed by many, largely to the extension and improvement of deep or sub-soil drainage, though this is denied by others; the low-water *régime* has next been greatly developed, by increased scour and dredging, so that the head of the low-water tidal prism, with twenty feet depth, which, a quarter of a century back, was below the Arsenal, at Woolwich, is now above the Dock-yard; thirdly, the removal of the old bridges adds about one-third more tidal water above bridge than was admitted half a century back; fourthly, the embankments have added a few inches to the range, by narrowing, straightening, deepening, and regulating the channel, by which the friction has been reduced, and the tidal momentum has been increased; but the additional quantity admitted by the removal of the bridges is six times the quantity resulting from embanking. The interesting question arises, "Had this tidal development, due to the removal of the old bridges, been fully realised at the time of the erection of the embankments?" And again, "Is five feet above Trinity a safe minimum height, above which no tide of the future will flow?"

An examination of the Admiralty tide-tables for the year 1878 will show on what particular days these exceptional tides may be looked for. For instance, near the spring and autumnal equinoxes we find the two maximum tides of the year. On the 20th and 21st of March, 1878, the calculated height is 22 ft. 3 in. above the Admiralty low-water datum, or 2 ft. 2 in. above Trinity standard of high water; and on the 28th of September it is 2 ft. 1 in. above Trinity. Also on the 19th and 20th of February the height is estimated at 1 ft. 11 in. above; and on the 18th and 19th of April, 1 ft. 8 in.; on the 30th and 31st of August, 1 ft. 11 in.; and, lastly, on the 27th of October, the height is estimated at 1 ft. 9 in. above. So that, at six periods of the year, viz., in February, March, April, and in August, September, and October, 1878, tides 2 ft. in excess of Trinity may be looked for; and, if accompanied or preceded by strong northerly winds, 3 ft. excess may be anticipated, and if these north winds increase to gales, 4 ft. may be expected; and if, lastly, there is an accompaniment of heavy land floods, an increase of from 4 ft. to 5 ft. may be predicted above the normal spring range denoted by Trinity standard.

It is also to be noticed that two or three tides preceding and succeeding these equinoctial tides are estimated to rise within a few inches of the maximum, so that, under like conditions, they will be nearly as lofty, or with more wind may even rise higher.

The tides of last springs only flowed about 9 inches higher than the Admiralty calculated height, due to the absence of northerly wind.

The influence of a S.W. gale was shown in a remarkable manner; the morning of Monday, the 21st January last, when the tide ebbed one hour and a quarter beyond the due time, and fell unusually low, viz., to 23 feet 2 inches below Trinity standard; on the 2nd April, 1859, and the 21st October, 1874, under like conditions, the tide ebbed to 23 feet below Trinity; they are the lowest recorded for the past half century. Under these conditions, the remains of the foundations of old London-bridge, and the piles around the piers of the existing bridge are visible, also a belt of sand and silt beyond the camp sheeting in front of Calvert's and other wharves—rarely visible; the footings of Southwark-bridge piers, the iron cylinders below the stone piers of Blackfriars railway bridge, the extensive beds of broken stone around each pier of Waterloo-bridge and the concrete footings around the piers of Westminster-bridge, are all unusually exposed; and the "long shore" population turn out on foot along the shore in front of the face of the embankments, and in boats, to collect iron bolts, chains, and other "waifs and strays." At Ramsgate, where the gauge does not register so low as the tide ebbed, it is reported by the harbour-master as low as ever seen by him, and 2 feet 6 inches lower than an ordinary spring ebb; at Dover it ebbed to the same level; at Sheerness to 3 feet below the same, and registered 22 feet 7 inches below Trinity, so that the water surface was depressed seven inches lower in the Port of London than in the estuary, by the force of the gale, and this apparent anomaly is of frequent occurrence.

The whole subject of the river is replete with interest in a metropolitan and national point of view, more especially as some well considered measure is necessary to secure the inhabitants of low-lying London from the evils the altered hydrodynamic condition of the metropolitan portion of the Thames has brought about.

DISCUSSION.

Mr. Cooke said he had recently seen in the British Museum some interesting old maps showing the course of the Thames, and also some views of the bridges. Altogether there were 44. They were very interesting, and would be found in the King's library. In Knight's "London," there was also an interesting paper on the Thames, showing how carefully fish were preserved in former times, and he was glad to find that this was still being attended to. It also appeared from FitzStephen that as early as 1190 there were swans on the Thames, and he would suggest with regard to them the plan he had seen adopted in Holland of putting a ring round their necks instead of marking them as was the practice here. With regard to high tides in the Thames, he thought the predictions of Col. Saxby deserved great attention.

Admiral Sir Erasmus Ommanney, C.B., F.R.S., congratulated the author of the paper on the very interesting historical sketch he had given. With regard to his suggestion as to the improvement of the river he might say, as a member of the Conservancy Board, that since 1866 great improvements had taken place in the upper part. Nearly all the locks had been rebuilt, and, certainly, as far as their resources went, they had done as much as could be expected. They had borrowed more than £40,000. They were now in a state of stagnation, but were going to bring before the present Parliament a Bill with a view to complete the improvements in the upper part of the navigation. Mr. Redman had suggested that £500,000 should be expended, but if they only had £100,000 he thought they would be able to carry out all that was suggested. They were still doing a great deal to improve the lower part of the river. Large dredges had been lately built, and improved barges for carrying the deposit down the river. The reach at Woolwich was being deepened, and most of the shoals referred to had been removed. He believed the watching and conservation of the river was never more zealously looked after than at the present time, and he should be happy to answer any questions which might be put with reference to their proceedings.

Mr. David Chadwick, M.P., gathered that the object of the paper was to call attention to the present state of the river, and to point out what might be done in the future. This had been the subject of constant attention during the last 20 or 30 years, and the author had done great service in condensing in so concise a manner all the information obtainable. All who had taken an interest in waterworks, sewage, and drainage must know that this noble river had never been utilised to anything like the extent of which it was capable. At Glasgow, a comparatively paltry stream had been vastly improved, to the extent of increasing a thousandfold the traffic to that great city. In fact, what had been done in London was quite inconsiderable in comparison with what had been done in Glasgow. If we had not done the same in London, the question was who was to blame? It occurred to him, from a cursory perusal of the paper, that the recommendations with regard to dredging were of great importance; and he should like another paper to be written, showing what effectual dredging would do for the Thames. He had seen dredging carried on in nearly all parts of Europe, but never so efficiently as in the Suez Canal, both during its construction and since. He had no hesitation in saying that the dredges constructed by the French engineers were more gigantic and efficient than those in Glasgow or anywhere else. This was a most important question, and he believed that if there were proper dredges for the river Thames, and the officers did their duty, the value of the river to this great community might be increased many fold. He hoped Admiral Ommanney would follow up the subject, and show how they could practically carry out the suggestions made.

Mr. Dibley thought the paper a most valuable one, and he thought it would be better appreciated when read at leisure in the *Journal*. Its main object was to endeavour to point out a means of preventing the recurrence of those floods which were looked forward to with such intense anxiety, and the course suggested was to deepen the channel so that there would be a greater overflow. The Clyde was under totally different conditions to the Thames, because the very existence of Glasgow depended upon the dredging of the Clyde, but there had never been the necessity in London for keeping the river dredged in order to allow the shipping to come up to the docks, nor did he think there was any blame attaching to the Conservancy Board, considering the means they had at command. The dredging was the most important part of the paper, and he presumed the reader meant that by that means the continual overflowings would be greatly mitigated, if not prevented, not merely in Lambeth, but in the other parts of the river. Last season it was a very serious matter, going up the river beyond Thames Ditton, to see the land overflowed and the houses inundated. It was not simply a question for the local board, but one which should come before Parliament, so that a grant might be given to the Conservancy Board to prevent the recurrence of these dreadful floods. With regard to dredges used in the Suez Canal, without in any way wishing to praise English engineers unduly, he believed that if a necessity existed, similar to that in the construction of the Suez Canal, English engineers would be fully capable, as they had been in all past instances, of competing with any of their foreign friends.

Mr. Reid wished Admiral Ommanney had said something on the controversy now going on as to the damage said to be occasioned by the outfall of the Board of Works. Capt. Calvert had made a report, which he understood was going to be answered by the Metropolitan Board, and he should like to know how the matter stood.

Admiral Ommanney said that at present no answer had been made to it.

Mr. Williams said one important point had not been referred to, viz., the lighting of the Thames at night. If it were thoroughly lighted from London-bridge to Woolwich, it would greatly facilitate navigation and prevent a great sacifice of human life. He thought this matter ought to engage the attention of the Conservancy Board, which, as far as his experience went, had done very little, indeed, for the river. The steamboat piers below bridge were in a very dilapidated and discreditable condition; but the more important point was the lighting.

Mr. Symons thought the conservators, with whom he was in no way connected, and did not even know who they were, had been rather severely attacked. If people knew what their powers and means were, he thought it would probably explain why they did not do one-tenth what they ought. But then came the question why did they not go for increased powers? It appeared to him the responsibility lay on anybody who undertook the management of a subject if they had not sufficient means to try and get them. They should either do that, or say, we cannot do the thing properly, and therefore we will not do it at all. His own impression was that there was a great deal to be done to the Thames. It had been turned into a *cloaca maxima*, was very often a nuisance, and let it generally get into a state by no means creditable to this country. But instead of blaming the Thames Conservancy for not doing the work, they should be blamed for not going for increased powers, and then they might have as good an organisation with regard to the Thames as was the case with regard to the Seine. For instance, take the question of the rainfall; they waited until the water came down, but why should they not send a telegram saying it was coming, and get the

river as empty as possible; then there would be a space for it to go into, instead of finding all the gates shut in the usual way. Anyone who went up and down the Thames knew that it was abominably lighted; he could not say who was responsible for that, but somebody ought to do it. There was certainly a great field for more work, but no doubt the main thing was the money.

Admiral Ommanney said that if gentlemen had seen as much of Parliamentary Committees as he had, and knew the difficulty of getting fresh powers, they would not talk so glibly about it. As he had already said, they were now trying for further powers. With regard to the lighting, the pilots said they were puzzled already with too many.

A Member said he believed it was the Trinity Board which managed the lighting of the river.

The Rev. J. Clutterbuck said he was more connected with the upper than the lower part of the Thames. He had lived on the banks of the river for 40 years, and had seen a great many floods, and many dry seasons, and there was no point he had attended to more thoroughly than that of floods. There was considerable misunderstanding with reference to the ease in which floods were to be got rid of. Looking at a geological map of the Thames valley it would be seen that a great part of it consisted of clay, which added to the difficulty. If they had the sinews of war they would fight the battle out, but they had had many difficulties, particularly in dealing with the landowners, who had offered the most bitter opposition to the scheme propounded by two most eminent men, Mr. Leech and Mr. Beardmore. That had hindered them for a time, but he hoped the time would come when they would have more money, and the more they had the better they would do the work. With reference to the anticipation of floods, with all respect to Mr. Symons, he thought that was something like a popular error. They knew what the capabilities of the weirs were, and to a certain extent what the floods were. He lived close to Clifton weir, which was particularly well adapted for making observations, because it stood below a mill, and above a weir which had no mill attached to it. One great difficulty was with the millers. Directly a flood came, the miller's object was to keep the head up, and get the tail down, and that had a great deal to do with the aggravation of floods, and until they had greater powers it was impossible to say you would let the flood go. There were certain rights which could not be interfered with. Records were now kept of the height at which the water stood, morning and evening, at the head and tail of the lock, and from that record he was able to make diagrams, showing how far the rainfall affected the floods. First of all it was necessary that the whole district whence the flood came should be thoroughly saturated; and when this took place, which was generally about October or November, every rainfall of about $\frac{1}{3}$ in. began to tell a little. There had been some heavy rainfalls of about 1 in., and that made about a third of the highest flood; and after a continuous rainfall of about 3 in. there would be a flood very like what was called the "Duke's flood." The flood at the beginning of last year exactly touched the point reached by the Duke's flood of 1852. It received that name because it happened on the 17th Nov., the day when the Duke of Wellington was buried; and so great was the flood about Oxford, that the people could not go to the funeral, because the railways were all blocked with water. The conservators were only hindered by what they could not surmount, viz., want of funds; and if the Legislature would grant them further powers, he hoped that if they came there again in four or five years there would be little to complain about, at any rate with regard to the upper part of the Thames.

Mr. David Chadwick, M.P., as a member of the House of Commons, and representing, to some extent, the economists, could not excuse the Conservancy Board on the mere ground of not having money at command. He had no hesitation in saying that they could get universal assent to any extension of their powers, and the raising of any sum of money, not only for preventing floods, but for improving the conservancy generally, for deepening the bed, and improving the scour. They had only to do what every efficient public body was required to do, make a report, accompanied by a statement of facts, and an estimate by their engineers, showing the benefits which would result, and Parliament would never be backward in granting any amount of money to a public body worthy of its confidence.

Admiral Ommanney said there was a return laid before Parliament every year, showing what had been done. Within the last year they had deepened the channel between Richmond-bridge and Teddington $2\frac{1}{2}$ feet.

Mr. Trewby said that a good deal of what had been said seemed to him rather wide of the mark. The paper was probably brought forward owing to the lamentable condition of the people, caused by the floods in London. The had heard a great deal of floods in the upper part of the Thames, but there there was a mere fringe of houses, and comparatively little harm was done; but when they had floods in the densely inhabited parts of London, such as Lambeth, the miasmatic effects and other evils occasioned by it, remained, and were carried amongst the people year by year. A low stamina, and a generally feeble condition of body resulted, but these poor people did not seem to be considered at all. The Thames Conservators had been called to account, but he could not see that they were at all affected, because their work mainly consisted in preserving the water-way, making regulations for boat races, and so on, and they were pretty well occupied, and their means exhausted in so doing. London seemed torn asunder by different governing bodies, for there were the Conservators, the Metropolitan Board, and a number of Commissioners all pulling different ways. When Westminster-bridge was built, strong representations were made of the injury which would be caused to the water-way of the river, owing to the low height of the arches; but the House of Commons, urged on, no doubt, by their architect, said it would spoil the appearance of the House of Commons if the bridge were built any higher, and the consequence was there was a low bridge obstructing the navigation. With respect to the floods, he thought that if the question were taken up in a practical way, and some scheme devised by which the whole of the property between Vauxhall and London bridges might be acquired, the embankment might be brought well out into the river, and docks formed at the back; no hindrance could take place to the due distribution of commodities by the aid of barges, and an immense benefit would be conferred on the whole of those poor people who were compelled to live there. These people worked for the whole of London, and their lives were kept in a state of misery because of those contending bodies who would not do the work which was required.

Mr. Wm. Botly said he contended some years since, in a paper which he read, that no houses should be allowed to be built less than 15 or 20 feet above high water mark. When he was a boy a large extent of land on the south side of the river was vegetable garden ground, which was now covered with houses, and he maintained that those who erected dwellings on this low swampy land had no right to come on the country generally to repair the mischief they had caused. Fever and other disorders were caused by these floods, and not only to those who lived there, but through them to the population generally. The onus should be thrown on those who turned these gardens into streets in order to ncrease their enormous rentals. Until there was some

legislative enactment to prevent building on such places, they would be continually harrassed in this way.

The Chairman, in moving a vote of thanks to Mr. Redman, regretted it was not in their power to propose a vote of a quarter of a million to the Conservancy Board to carry out the works which would be of such great benefit. There was no doubt that the deepening of the channel was the most important part of the work, and he was glad to find that this had already been done between Richmond and Teddington. After the way in which they had been taken to task they must be congratulated on having accomplished so much. They were also much indebted to Admiral Ommanney and the Rev. J. Clutterbuck for attending and giving the information they had.

The vote of thanks was passed unanimously, and the proceedings terminated.

MISCELLANEOUS.

ARTIFICIAL PRODUCTION OF PRECIOUS STONES.*

By MM. E. Fremy and Feil.

The following is a translation of a paper read before the French Academy of Sciences, a report of which appeared in the December number of the *Comptes Rendus de l'Académie des Sciences*:—Synthetic mineralogy (that is to say, the artificial production of minerals) presents, in a scientific point of view, an interest which everyone can understand; for it throws the greatest light upon the mode in which minerals are formed, and permits us to solve certain questions relative to their composition which chemical analysis often leaves undecided. In fact, a mineral which appears quite pure generally contains foreign substances intermixed which existed in the medium that formed it; analysis is then powerless to determine the real composition of the mineral, while a synthetic reproduction enables us to distinguish the constituent elements from those which are merely accidental. A great number of minerals have been artificially produced in the dry way, in the wet way, and by M. Becquerel's ingenious methods; and synthetic reproduction is daily receiving some fresh extension, as is proved by the recent discoveries of M. Hautefeuille.

Corundum has, perhaps, more than any other mineral exercised the sagacity of chemists. The excellent investigations on the different modes of crystallisation of alumina, which have been published by Ebelmen, de Senarmont, and since by MM. H. Sainte-Claire Deville and Caron, by M. Gaudin, and M. Debray, are well known to every man of science. Even after these remarkable researches, however, we may still interest the Academy by making known the processes we employ for the production of differently coloured and crystallised alumina (ruby and sapphire) in masses sufficiently large to be used in horology and to be cut by the lapidary. It will probably be possible to apply the methods we are about to describe to the artificial production of other minerals.

Wishing to approximate as nearly as possible to the natural conditions which have probably determined the formation of corundum, ruby, and sapphire, we have borrowed from industry its most energetic heat-producing appliances, which permit an elevated temperature to be produced and maintained for a long time, and considerable masses to be operated on; indeed, we have often acted on 20 or 30 kilogrammes of material, which we kept heated uninterruptedly for twenty days.

It was in the oven of M. J. Feil's works that we conducted the experiments which required the highest temperature. When our trials demanded prolonged calcination, we had recourse to a glass-furnace which was generously placed at our disposal by the company of Saint Gobain. In this case our essays were directed by an eminent chemist, M. Henrivaux, whose intelligent supervision secured their success. The following is the method which enabled us to produce the largest quantity of crystallised alumina:—

We commence by forming a fusible aluminate, and then heat it to bright redness with a siliceous substance. In this case the alumina is slowly separated from its saline combination in presence of a flux, and crystallises. We attribute the crystalisation of the alumina to various causes—either the volatilisation of the base with which the alumina is united, or the reduction of this base by the gases of the furnace, or the formation of a fusible silicate which, by the combination of its silica with the base, isolates the alumina, or, finally, a phenomenon of liquidation which produces a very fusible silicate and some hardly fusible alumina. All these cases presented themselves in our essays; but the displacement of alumina by silica appears to us the surest process for effecting its crystallisation. Several fusible aluminates lend themselves to these different kinds of decompositions, that which, up to the present, has given us the best results is the aluminate of lead. When a mixture of equal weight of alumina and minium is placed in a crucible of fire-clay, and calcined at a bright red heat for a sufficient time, two different layers are found in the crucible after cooling; the one is vitreous, and formed chiefly of silicate of lead; the other is crystalline, often presenting masses of beautiful crystals of alumina. In this operation the sides of the crucible act by the silica which they contain. They are always made thinner, and often perforated, by the actions of the lead-oxide; therefore, to avoid loss of the product, we usually conduct the operation in a double crucible.

The experiment just described gives white crystals of corundum; when we would obtain crystals presenting the rose-colour of the ruby, we add from two or three per cent. of bichromate of potass to the admixture of alumina and minium. The blue colouration of sapphire is produced by employing a small quantity of oxide of cobalt mixed with a trace of bichromate of potass. The ruby crystals thus obtained are ordinarily coated with silicate of lead, which we remove in various ways—either by the action of fused oxide of lead, or hydrofluoric acid, or by potass in fusion, or by prolonged calcination in hydrogen, and afterwards by the action of alkalies and acids; but in certain cases we find some nearly pure crystals, which then exhibit all the characters of the natural corundums and rubies — possessing their compositions, adamantine brilliance, hardness, specific gravity, and crystalline form. Our rubies, in fact, scratch quartz and topaz: their specific gravity is 4·0—4·1. They lose, like natural rubies, their rose-colour when strongly heated, and resume it on cooling. Submitted to lapidaries, they have been found as hard as, and often harder than, natural stones. They rapidly wear away the best grinders of hardened steel. M. Tannettaz has kindly submitted our rubies to crystallographic observations; with the microscope they present a black cross in their interior, and coloured rings upon the margins. The crystals which we have had cut, and now exhibit to the Academy, have not yet the brilliance demanded by commerce, because they did not present to the lapidary faces favourable for cleavage and cutting; but here are some crystalline masses weighing several kilogrammes, amongst which we shall doubtless find some that can be easily cut.

* Paper read by MM. Fremy and Feil before the French Academy of Sciences, and translated in the *Watchmaker, Jeweller, and Silversmith.*

We will now describe the method which has enabled us to produce the fine specimens of crystallised silicates which we lay before the Academy. The experiments about to be described are connected with the preceding; for they have frequently given us crystals of corundum together with crystallised silicates. It was by means of fluorides that we produced the crystallised bodies of which we have still to speak. In carrying out these researches we have had the opportunity of appreciating all the accuracy of the observations of M. Daubrée, who first demonstrated the important part played by fluorine as a mineraliser, in the formation of mineral beds and of silicates. Those views are confirmed anew by our experiments. Guided by the classic writings of M. Henri Sainte-Claire Deville, we have ascertained that, of all the mineralisers, perhaps the most active is the fluoride of aluminium. Submitting a mixture of equal weights of silicate fluoride of aluminum to a red heat during several hours, we verified that by the mutual reaction of the two substances fluoride of silicium is liberated, and a crystallised body is obtained which appears to be kyanite—that is, silicate of alumina. According to the determinations of M. Jannettaz, this body occurs in doubly refracting acicular crystals, which extinguish light obliquely with respect to their edges. Doubtless they belong to one of the oblique systems—the oblique prism with rhombic base, or the doubly oblique prism. These crystals give the following composition:—

Silica	47·65
Alumina	51·85
Loss	0·50

This comes near to the composition of natural kyanite.

The action of fluoride of aluminium on boric acid gave a crystallised borate of alumina which corresponds to kyanite. We are at present carrying out a series of trials in which fluoride of aluminium will act upon other mineral acids. The important fact of the volatility of the fluoride of aluminium, discovered by M. Henri Saint-Claire Deville, enables us readily to explain the remaining experiments. When a mixture of equal weights of alumina and fluoride of barium, into which has been introduced two or three per cent. of bichromate of potass, is heated to and maintained at a very high temperature during a long time, a crystallised mass is obtained, the study of which is of the greatest importance. If the calcination has been effected in a crucible covered with another (which serves in some sort as a condenser), two sorts of crystals are found in the crucibles: the one sort are long colourless prisms, often several centimètres in length, and presenting the aspect of the silvery flowers of antimony; the others are ruby crystals, remarkable for the regularity of their forms and beautiful rose-colour. The long prismatic colourless crystals are formed by a double silicate of baryta and alumina, which present the composition:—

Silica	34·32
Baryta	35·04
Alumina	30·37

In our essays this double silicate often crystallised in rather short, hard, and transparent clinorhombic prisms, which M. Terreil has ascertained have the same composition as the long and hollow prismatic needles. M. Jannettaz has proved that the long prisms often constituted by four plates with parallel faces, forming the faces of a hollow prism. These plates are very thin; under the microscope they extinguish light, or, rather, they let darkness persist between two Nicols, parallel to their mutual intersections; the plane of the optic axes is parallel to these intersections; they cut one another at angles of 60° 42′ and 119° 18′.

There is, therefore, produced in this curious reaction corundum and a crystallised double silicate. These two crystalline substances result from the following transformations: In the calcination of the mixture of alumina and fluoride of barium there are evidently formed fluoride of aluminium and baryta. The fluoride of aluminium, once produced, must have acted in two different ways. Decomposed by the gases from the furnace, it formed hydrofluoric acid and corundum, which crystallised under the influence of the vapours. Acting besides upon the silica of the crucible, it gave rise to silicate of alumina, which, combining with the baryta, produced the fine crystals of double silicate of alumina and baryta which we exhibit to the Academy. Such, in our opinion, is the theory of the reaction.

Permit us now to dwell on the conditions which have determined the crystallisation of the two substances, corundum and the double silicate. Looking at the specimens we here exhibit, and which present such well-defined crystals, one is struck with the place which they occupy in the crucibles: they seem to have been volatilised; and yet we have ascertained, by exposing them to the highest temperatures of our furnaces, that they are absolutely fixed. It is because the fluorides are not merely powerful mineralisers, they are also compounds which, as was formerly said, give wings to the least volatile substances. Do we not recollect, indeed, that remarkable formation of orthose felspar produced artificially and found in the upper part of a copper-furnace at Mansfeld? The employment of fluoride of calcium in the melting-bed of the furnace which produced that felspar permits the belief that the fluorine intervened in that case as a transporting agent. It was evidently this which presented itself in our experiments, as in those which have been so often performed by M. H. Sainte-Claire Deville; the agents in the crystallisation of the corundum and the silicate were likewise the fluorine compounds which we employed. It was to be presumed that this action of fluoride of barium upon alumina in presence of silica, forming a crystallised double silicate, would reappear as a general phenomenon connected with the decomposition of the fluorides by different bases. This we have, in fact, proved. In another communication we will describe some crystallised double silicates produced under the same conditions as the double silicate of alumina and baryta; and then we shall give the general formulæ of these compounds.

Such is the brief account of our researches which we wish to present to the Academy. It is probable that our experiments, which give, in considerable masses, substances whose hardness is comparable to that of the natural ruby, will be utilised from time to time by the watchmaker, and even by the jeweller. We will say, in conclusion, that in this labour the aim we pursue is exclusively scientific; consequently, we put into the possession of the public the facts we have discovered, and shall be very happy to learn that they have found useful industrial applications.

Since the commencement of the present year, the Commissioners of Patents Journal has given, in addition to the usual information about grants of, and applications for, Letters Patent, &c., a list of the useful and ornamental designs registered each week, and of the trade-marks advertised and registered for each class. In both cases the name of the applicant and the register number of his application are given.

Mr. Nobel, the inventor of dynamite, is stated to have discovered a yet more potent explosive, known as "blasting gelatine." It consists of 93 or 94 per cent. of nitro-glycerine, and six or seven per cent. of collodion-cotton, so mixed up as to form a gelatinous substance. It is tough, but may be made into cartridges, cakes, or balls; and may be easily cut with a knife or scissors.

The stems of the wild rice plant, which abounds in the swamps, ponds, and shallow streams of North America, have been mentioned as a suitable raw material for the paper manufacturer. Practically inexhaustible supplies might be obtained from Canada, but it is stated to be too bulky to pay for importation unless it were converted into "half-stuff" or pulp.

REPORT ON OLIVE CULTURE WITH A VIEW TO ITS INTRODUCTION INTO NEW ZEALAND.

Amongst official papers recently printed in New Zealand under Government authority, is a very exhaustive report on the culture of the olive as practised in Tuscany. This report was written for the purpose of supplying accurate information for the benefit of those wishing to grow the olive in New Zealand, and with the view of establishing what might eventually prove an advantageous industry in that colony. For the purpose of obtaining information for the report, the writer, Mr. John Glyn, of Leghorn, visited the several districts of Tuscany, such as Montojoli, San Romano, the Pianura di Pisa, and the hills in the neighbourhood of Leghorn. San Romano is described as being the very centre of a large olive-oil making industry. The country around is undulating and very beautiful, the soil appearing mostly of an argillaceous sandy nature of some two mètres in depth, resting upon gravel or tufa, and in some cases upon blue Staffordshire clay. The olive trees on these hills have been in their present positions from time immemorial; in fact, it is almost believed by the educated that some of them may have been the actual descendants of those planted by the Phœnicians 600 B.C. The word descendants is used because, although an olive may be utterly damaged above ground either by intense cold, fire, lightning, or other causes, there is so much vitality and tenacity of life in the roots that within a short time it sends up fresh shoots which soon become prolific trees. No one is able to fix a limit to its longevity. Bouche gives it upwards of 1,000 years. The trees grow to a very large size when old. There was in Provence some years ago an old olive tree still bearing fruit although quite hollow, and able to contain as many as twenty persons in its cavity; and even in Tuscany, where every care is given to the culture, the remains of trees are constantly to be seen which have been struck by lightning yet vigorous and productive, even when in the surviving half a large portion of the centre may have been worn away. There is no doubt that the olive is one of the most profitable plants that a farmer or landed proprietor can put into the ground, as, if once planted and carefully attended to in its earlier years, it will become a source of perennial income, living on as it does from generation to generation.

The olive is found within a few miles of the sea in nearly all parts of the Mediterranean coasts. Even in Africa it grows in the highlands, but only to a short distance inland. Here the yield of oil is not great, owing to the heat, which frequently dries up the sap, so that the oil is of an inferior quality. The most suitable climate for the tree is a temperate one, such as that of Tuscany, and perhaps Liguria, where its cultivation extends to the tops of the hills up to a height of from 700 to 1,000 feet above the sea, where the cold is intense in winter and it is not overpoweringly hot in summer. The general opinion is that it thrives best within a short distance of the sea, on hills with rocky or argillaceous gravelly soil. The aspect is of no consequence. Too great heat or drought materially reduces the quantity as well as the quality of the oil, rendering it thick, rank, and greasy; nor is severe cold favourable to good crops. Temperate heat and mild winters are best suited to rapidity of growth and large yields of oil; from this it is considered that the climate of New Zealand, and more particularly that of the Northern Island, is well suited for olive culture. The soil should not be too rich, or else the oil produced is fatty and rank, neither should the trees be planted in a plain, as when the drainage is defective, the ground is apt to get sodden, which is injurious to the roots. Hills admit of natural drainage. In some parts of Tuscany, in the plains, where the soil is damp, in order to ensure a perfect drainage, which is absolutely necessary, an artificial bed of gravel, stone, or broken rocks, or tufa, is prepared of some depth, and thick layers of rich earth laid above this, so that superfluous moisture may drain off. Provided the plantations admit of an entirely free circulation of air to all parts, and the drainage is perfect, a moist, rainy, or windy climate, if not too cold in winter, is anything but prejudicial to this plant; in fact, the oil is likely to become of a more fluid character in consequence, a great desideratum with Italians. In many parts of this province, as well as in Lucca, the hills, that have but little earth on the rocks of which they are composed, are formed into terraces by walls of loose stones. On these platforms they collect all the earth they can, and successfully plant their olives, which are renowned for the quality of the oil. Even where the soil is poor, they will dig a large hole, fill it with rich manure, and put their trees therein. Winds are considered favourable when coming from the sea; they are supposed to contain saline matter; but the olive does not benefit by being exposed to the sea spray. From this it appears to be the opinion of the generality of these people that proximity to the sea is useful, although it is proved that the plants thrive beyond Florence, some sixty or seventy miles inland. In Tuscany, the winters often show as much as from 4° to 8° Reaumur, and in 1709 the cold was so intense as to prove disastrous to the olives, depriving many families of their chief support for several years; in fact, until the trees that had suffered had time to grow and bear again.

The finest oil in the world is produced in the province of Lucca, about 20 miles from Leghorn. The next best quality is Tuscan, then Ligurian, Provence Neapolitan, Sicilian, Spanish, Smyrna, and Tunisian, the last being a thick strong smelling oil, and used only for soap making and machinery. From this it will be seen that the temperate climate of Italy is that best adapted to the growth of this tree. The forest oil is of a beautiful straw colour, slightly tinged at times with green of extraordinary brightness, very liquid, almost without smell, and of exquisite flavour. It is used by the best families on the Continent for cooking purposes in place of butter, and for salads. The estimated value of the entire yield of oil in Italy is stated at not less than £30,000 sterling.

Regarding the introduction of the olive into New Zealand, and the chances of its success there, Mr. Glyn says that the Italians have informed him that they would carefully cut out the knots or eyes growing out of the trunks of the trees near the base or ground. The best time for this is in the month of October. These they would cover up in earth and moss, then put them into casks filled with sand, which is watered and closed up, and if sent a long voyage by sea it would be beneficial to sprinkle them occasionally, so as to keep them fresh and cool within the tropics. In this way they would bear exclusion from the light for several months. On arrival in the colony, they would require to be taken out with care, and put into well-prepared ground, until such time as they had taken root, when they should be dug out with as much surrounding earth as possible, and put into the sites intended for their permanent abodes. These sites, however, should be holes six feet square and four feet deep, filled with a manure of ground bone, horns, hoofs, well fermented horse-dung and sheeps' or bullocks' blood. They would now require such skilled treatment (as the future well-being of the trees depends entirely on this period of their existence), that the employment of Italians, and more especially those thoroughly conversant with this branch of culture, is recommended. In the pruning of the trees great care is also required, indeed, it is said that it can only be done properly by those whose knowledge has been acquired by years of practice. The trees will begin to bear fruit in five or six years, and the only care they would need would be the cutting of a trench round their bases and dosing them in the spring with liquid manure. They will flourish if treated with potash, soda, lime, silica, or manures containing

these salts; feathers and the scrapings of tanneries are often used by the Italians, as these things take long in decaying. They should be placed in rows at from eight to ten feet from each other, at which rate it is estimated that an acre would contain from 400 to 500 trees.

In Italy the olive grounds are not unfrequently manured with the matter from cesspools. These receptacles are the monopoly of the municipality, and are periodically emptied by properly appointed people, who take the stuff into the country, where it is sold to the farmers, who pour it over their fields after ploughing. It is more fluid than the London sewage, and is considered of excellent quality, being exclusively house drainage. In Italian olive grounds the fruits are usually gathered in the months of October and November, or even up to Christmas; but by this time they become nearly black. After gathering, they are taken to the crushing mills, and the refuse is put into cane bags and subjected to great pressure in a machine. The first process produces the finest quality or virgin oil; the second and third, inferior qualities. The hard kernel, or stone, is crushed for the small quantity of oil it contains, and the pulverised mass, after boiling, is generally used as fuel. Cattle are so fond of the bark and foliage of this tree, that it is said to be necessary to fence the fields where it grows. Rabbits are also very destructive to it, but it does not suffer much from injurious insects, more particularly if it is planted in good soils and favourable positions.

It is calculated that the value of a good oil crop, in all the countries were the plant is cultivated, cannot be less than £100,000,000 sterling annually; and the demand is continually increasing. The French produce large quantities, but not sufficient for their wants, as they took from Leghorn alone in one year 3,300,000 kilos. Owing to their enormous trade in sardines and other articles in oil, their own supply is totally inadequate to the demand. The consumption of oil in Italy is something marvellous. It is used by the people daily, and enters largely into nearly every dish brought to the table, even to their sauces and pastry; and when meat is scarce, or altogether absent, they will put it into their pottage; thus with bread, rice, or paste and tomatoes, chopped herbs and vegetables, they make a savoury mess. In Spain, the south of France, in Greece, and in the Levant, it forms one of the chief articles of diet. In Italy the oil is also used in large quantities by the better classes as an illuminating agent. The Opera-house at Florence is lighted solely by moderator lamps, and the light given by the great chandelier, which contains a vast number of these lamps, is inexpressibly soft and agreeable, being brilliant without glare.

In general, the Italians do not plant any grain or green crops under the olives. In some parts, where the trees stand far asunder, they cultivate the vine; but it is admitted that both the olives and grapes suffer in consequence. Italian agriculturists are of opinion that in those countries that have mild winters, and where vines, the fig tree, and the Indian corn thrive and ripen, the olive must necessarily prosper.

Mr. Glyn sums up this notice of olive cultivation as follows:—Taking into consideration the great range of country, namely, from the 34th to the 46th degrees of north latitude, where the olive is found, and the infinite variety of climates in which it exists, it has been proved that between the 43rd and the 45th parrallels of latitude, the finest qualities are produced, and that it will flourish and grow vigorously in all this space when not too far away from the sea. Although the quality may be, and doubtless is, materially affected by such causes as climate, position, soil, &c., there is no doubt of its being capable of bearing transplantation to the southern hemisphere. The abortive attempt to introduce it successfully into Australia must be attributed to want of skill and experience in the people employed, and not to any fault of the climate. If necessary, I would guarantee its successful introduction into New Zealand, and am convinced that no country is, in point of climate, better adapted for it than the greater part of the Northern Island, and can recommend it as being one of the most profitable sources of wealth that providence can confer on a country. Further, I have no hesitation in stating that, with a very moderate outlay, 100,000 plants might be sent out and be put into the ground before the expiration of six months.

PARIS ETHNOGRAPHIC MUSEUM.

Another museum has been added to the institutions of Paris, a museum devoted to the results of scientific missions which arose out of the Universal Exhibition of 1867, and which results will be comprised in the coming exhibition of the present year.

In two many instances the results of scientific missions, often highly interesting or useful, are only reported in publications, which few people read, while the material results are hidden away out of the sight of the scientific public. The new museum, which owes its existence in a great measure to M. Matteville, is intended to remedy that state of things. Each person who has been charged with a mission will here have the opportunity, as it were, of giving to the public a complete report of what he has done and obtained; and a collection of the fabrics, arms, and other articles, the produce of people in various stages of barbarism or semi-civilisation, will be an element of general instruction.

One of the first series of collections that meet the eye in the new museum, which is established in the Palais de l' Industrie, is that made by M. Devière, who has particularly interested himself in prehistoric man. In the grottos of Mentona and Grimaldi, he found the teeth and bones of various animals, with an important series of flint axes, beads, *celtæ* of all kinds, such as are found in abundance by Carnac. He brought home, amongst other things, impressions in paper of inscriptions in Punic characters made by the soldiers of Hannibal on walls near their camp.

M. Ujfalvy went on a mission by way of the frozen sea of Aral, traversed Western China, and returned by Siberia. In these regions, he says, scarcely known to savants, the development of races is going on which may produce great changes, and yet are scarcely perceived by us. Russia gradually advances her empire, absorbs growing populations which presently may supply her with hardy soldiers. M. Ujfalvy visited Samarkand, where Tamerlane gathered together the riches of a hundred conquered nations, a camp full of spoils, and in the midst a pyramid of 80,000 skulls. In the museum will be found some enamels which decorated the mosques of Schah Sindab or of Hazzan, a fire bomb, a curious wooden prayer tablet, rude musical instruments, and tools of the most primitive form. From above Samarkand, the seat of the Autochthonous Argans, the forefathers of the Indo-Europeans, who seem to have had an instinct and taste for art, he has brought trinkets, copper vessels, admirably wrought coffers, harness encrusted with turquoises, thread made of the fibre of a plant of the nettle kind—like china grass or rheea—specimens of the coal of the country, and a curious illustration of an embroidered fabric produced by stamping the desired pattern by means of a wooden stamp and yellow powder.

From China, are visiting cards, porcelain plaques, perfume burners, brick tea, and many other articles. From Peru, M. Wicaer has brought an interesting collection, including a faithful reproduction of an ancient Peruvian habitation, and an Indian lodge of the present day almost hidden by thick foliage. There are specimens of the pottery of the country, uncovered vases found in the excavations made at Pisaro near Cuzco, recalling Etruscan

forms; and inscriptions in hieroglyphics dating back four thousand years before our era.

From Columbia and Equador, explored by M. Edouard André, are many inscriptions, a stone from Pandi, in Columbia, in which historical events, victories, and important facts are recorded in the same manner as they were in ancient Egypt. Amongst other events recorded is the rupture of the boundaries of the ancient lake of Sunapica, the waters of which precipitated themselves into the valley of Magdalena forming the Rio Sunapica. There are rudely sculptured figures of the sacred owl, found in the ruins of the temples; and large figures of war and of labour, said to have formerly guarded the doors of the sacred palaces. This collection, or rather this museum, will eventually be permanent, but the present contents will be included in the historical collections of the Universal Exhibition.

CORRESPONDENCE.

BAMBOO AS A PAPER-MAKING MATERIAL.

Desiring to ventilate this important question thoroughly, more especially in relation to the growth, cultivation, and productive power of the bamboo itself under irrigation, I addressed some queries on this point to Mr. Thomson, as he had not referred to it in his letter to Sir Joseph Hooker, which you published in the *Journal* of the 4th January last, and I now send extracts from his letter in reply, for which I hope you will find space in this week's issue.

Thomas Routledge.

Claxheugh, Sunderland,
25th February, 1878.

Dear Sir,—With reference to your letter of 30th December last, addressed to me in Jamaica, and which I only received a few days ago, it having been returned to me here from Jamaica, I beg to submit my further views on bamboo cultivation.

Jamaica has a very striking variety of climates in the lowlands more or less suitable for bamboo growth. This variety of climates has been caused by the improvident destruction of the forest. Bamboo on the drier plains presents a shrivelled and stinted aspect, except when within reach of water, which ensures its wonted luxuriance, it therefore assumes its greatest luxuriance in the most humid districts. Many hundreds of acres of certain districts are densely covered; for instance, a certain part of the parish of St. Thomas is literally covered with it. The plant flowers and yields seed in Jamaica under very exceptional circumstances, so that seeds are rarely seen. I have never been fortunate enough to see it in flower. It has been widely distributed owing to the readiness with which cuttings grow in most climates. The ripe stems are commonly used to form fences, the post and rails consisting of the stems; the posts, if placed in the ground prior to the rainy season, take root, and unless they are frequently trimmed become irrepressible thickets. Ripe stems of medium size are not uncommonly used by the Negroes as poles on which to support each plant of Yam, which climbs over the pole in their cultivated "provision grounds;" these stems in like manner grow. This will explain the facility with which the plant is propagated—though it is likewise propagable by offsets or rhizomes, I think, however, the stem process of propagation would be in every respect preferable.

With regard to the question as to the period required to produce "crops by planting," I am quite sure that this period could not be diminished by planting offsets from established stools. It should be remembered that by any system of propagation of the bamboo the first process of rooting is very simple; the result of the first roots is the production of slender, twiggy shoots, but as these latter become matured the increased vigour of the root action creates stems with proportionately increased strength, and so on step by step until the fully developed stems are producible; the whole length of time, from the time of planting, as I have already mentioned, for the maturation of the crop being at least two years.

An individual stool, if influenced only by the ordinary rainy seasons, I think, would not produce more than one crop in a season, but under a system of irrigation I am strongly inclined to believe that two crops would be producible. For the wants of the paper manufacturer it will no doubt be supposed that the available command of bamboo obtainable may be turned to account, instead of having resort to the formation of plantations. I will, however, briefly endeavour to show that a regular plantation possesses immense advantages. The existing bamboo, though only a few miles from shipping ports, is not so conveniently situated as it would be in a special plantation, on which the most advantageous and accessible spots would be set apart and systematically planted in a series of plots, in order to facilitate and economise cutting and carriage. The advantages thus indicated would be considerable, but the great advantage of planting bamboo would be that of having it brought under the influence of irrigation, as it is peculiarly a water-loving plant.

It is well known that general crops of bamboo shoots are only produced after heavy rains, a fall of from 15 to 30 inches; such rains usually occur two or three times a year in Jamaica; the time young shoots take to spring from the ground up to about 25 feet (they are at this height in a fit condition for your requirements) after such rains averages five weeks. Irrigation would produce constant action at the roots, and there can be no doubt that by the process of cutting, which I advocate (*vide* my letter of the 6th Nov.), several crops a year may be secured; indeed, a continuous succession of cropping could be assured by systematic cultivation and irrigation.

To those who have not visited the tropics it is impossible to conceive the extraordinary luxuriance of this gigantic grass. The description you give in your valuable pamphlet is far short of its majestic grandeur.

In laying out a plantation, I think that cuttings should be set about four or five feet apart; thus by planting thickly the intervening surface would be expeditiously occupied by the stools, and this system ensures the benefit of fostering among the plants a reciprocal tendency to shoot upwards.

The cost of planting would be about £2 per acre. After planting, four or five weedings, costing ten shillings, would be given during the two years required to establish the plantation. Subsequently to this cultivation would be absolutely dispensed with, except the application of water and a judicious system of cutting out the stems.

The Government of Jamaica has constructed at great expense magnificent irrigation works on the St. Catherine Plain, surrounding Spanish Town, and as very little advantage has been taken of this precious adjunct to tropical agriculture, land is obtainable at a very cheap rate, and it is most conveniently situated, as the railway connects it with Kingston, only 15 miles distant.

The irrigation works are constructed to irrigate upwards of 14,000 acres, but only a few hundred acres of cultivation have actually been brought under the influence of this water. Labour would be abundantly obtainable at 1s. 6d. a day; hundreds of strong negro labourers would be at command all the year round, and for rough and continuous hard work the negro is far superior to the coolie, and they prefer any kind of work to sugar estates work.

The Government undertake to supply a quantity of

water (as I mentioned in a previous letter to you) equivalent to a rain-fall of 60 inches a year for £1 per acre per annum; this is very moderate, as it would certainly double or treble the crops of bamboo annually as compared with the ordinary seasons. The average rainfall of the locality in this irrigation scheme is about 40 inches.

Our bamboo is *Bambasa vulgaris*, but, of course, you are aware that all the varieties are most productive in localities in which moisture is most abundant. This is a most important consideration, in view of the production of bamboo in Jamaica, and one which has, perhaps, not received any attention; the variety of climate as regards moisture is very remarkable. The destruction of the forest in most parts has materially lessened the rain-fall; certain districts are too dry for bamboo to exist in, others only afford sufficient moisture to maintain the bamboo in a condition of very partial luxuriance; it therefore follows that districts having a constant precipitation of rain, with a normal average of from 80 to 100 inches a year, are best adapted for this plant. Astonishing crops under irrigation, therefore, would be obtainable at a small cost of production, for it would require little or no cultivation beyond its first establishment.

I agree with you that it would not answer to export the bamboo in any other way than manufactured into paper stock, not only on account of the great difference in the cost of transport, but owing to the deterioration of the article in transit, when it is sent in a crude state, due to the difficulty in drying the young stems, even after crushing.

I may mention, that before your pamphlet was published, I was impressed with the notion that bamboo was destined to become the most valuable of all materials for paper-making, by reason of the quantity of it producible per acre, a quantity of fibre far greater than can be produced from any other plant, a fact to which you have referred. It should be remembered that bamboo grows its whole height in a few months, that the great bulk of it is composed of fibre which is convertible into paper stock, and that it produces its stems so closely, that is to say, each stem about 60 feet high (*Bambasa vulgaris*) occupies about half a square foot. Thus it does not require, as you state at page 8 of your pamphlet, two feet; half a dozen at least grow within two feet. Indeed, I should scarcely like to say what quantity of bamboo may be realised per acre, but it may be safely predicted that it will be so large that it will revolutionise the paper trade.—Remaining yours truly, Robert Thomson.

11, Queen-square, Bloomsbury, London,
22nd February, 1878.

GENERAL NOTES.

Health and Sewage of Towns.—*The World* says:—"I have heard of yet another case of serious illness caused by the ignorant carelessness of that most ignorant and most careless of British workmen, the plumber, who, as usual, had established a connection between the water-cistern and the sewer by means of an overflow pipe, and by this simple arrangement poisoned a family. As railway companies cannot carry passengers until their lines have been surveyed and approved by the Board of Trade, and as steamboat companies are subjected to a like inspection and control, I am not able to see why the speculative builder and the intelligent artisan should be free to work their wicked will, and put in imperfect drains, badly-planned pipes, and other lethal arrangements for the discomfort and destruction of the British householder. If landlords had to produce certificates of sanitary perfection before they could let houses, and if the expense caused by gross neglect and 'scamping' were legally deducible from rents, we should have less typhoid fever."

Telephones without Electricity.—Mr. W. J. Millar, C.E., of Glasgow, writes to announce the result of experiments with the string and drumhead telephone. Mr. Millar has carried on conversation through 50 yards of stretched wire, the wire being led round angles, from room to room of a house, and finally to a distance from the house. The sound of a tuning fork has been transmitted similarly through 150 yards. Mr. Millar considers that very much depends on the form and arrangement of the mouth piece of the disc, but his experiments on these points are not concluded. It is hoped that many practical applications of the principle may be made.

Adulterants of Sugar.—It appears that the granulated white sugars found in the American market, and the products of United States refineries, are subject to adulteration more or less strange. The fact of their producing syrups of different tints suggested an examination of their quality. Samples were found containing a considerable proportion of ultramarine, which, after several days' standing, was deposited. Syrups made from sugars having the ultramarine impurity are discoloured, being usually of a pale straw colour. This adulteration, and additions of sulphate of tin, alum, &c., we are told, are used by refiners in the interest of dollars and cents, and are designed to neutralise the yellow tint in imperfectly refined sugars. The practice is known among refiners as adding the complimentary colour. Unquestionably ultramarine adulteration is chemically injurious, being decomposed by fruit or organic acids with evolution of sulphuretted hydrogen, which produces a disagreeable taste; apart from this serious objection, the officinal syrups instead of being colourles and bright, are tainted and dull in appearance. It is satisfactory to be told that pure sugars can be had by purchasing from first-class manufacturers and paying a slight advance on the price of ordinary marketable granulated white sugar.—*British Trade Journal.*

NOTICES.

THE LIBRARY.

The following work has been presented to the Library:—

Wholesome Houses; being an Exposition of the Banner System of Sanitation, by Edward G. Banner, C.E. (London: Crosby, Lockwood and Co., 1878.) Presented by the Author.

The following Pamphlet has been presented:—

Two Letters on Indian Public Works; being a Rejected Letter to the *Times* in answer to Sir James Stephen, and a Letter to the India-office in answer to Lord George Hamilton, by Sir Arthur Cotton. (Dorking, 1878.) Presented by the Author.

The following has been purchased for the Library:—

A Treatise on Photography, by Captain W. de W. Abney, F.R.S. (London: Longmans, Green and Co., 1878.)

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at eight o'clock. The following arrangements have been made:—

March 6.—"An Electric Lamp-lighting System." By St. George Lane Fox, Esq. Prof. Tyndall, F.R.S., LL.D., D.C.L., will preside.

March 13.—Further Remarks on Lightning Rods." By Dr. R. J. Mann, F.R.A.S., Vice-Pres. Meteorological Society.

March 20.—"Emery and Corundum Wheels for Grinding and Surfacing Metals and other Materials." By A. H. Bateman, Esq., F.C.S.

March 27.—"State Aid to Music at Home and Abroad." By Alan S. Cole, Esq.

April 3.—"Our Wealth in Relation to the Imports and Exports of the Country," by E. Seyd, Esq. W. Hawes, Esq., F.G.S., will preside.

African Section.

Tuesday evenings, at Eight o'clock. The following arrangements have been made:—

March 19.—Egypt; its Commercial Changes and Aspects." By B. Francis Cobb, Esq.

Indian Section.

Friday evenings at eight o'clock. The following arrangements have been made:—

March 15.—"The Colonisation of Hill Districts in India." By Lieut.-General McMurdo, C.B. Edwin Chadwick, Esq., C.B., will preside.

March 29.—"The Depreciation of the Value of Silver, with Especial Reference to the Exchange between India and England, and Suggestions for a Remedy." By Col. J. T. Smith, R.E., F.R.S., formerly Master of the Mint, Madras and Calcutta.

May 3.—"On the Telegraph Routes between England and India." By Major Bateman-Champain, R.E.

Cantor Lectures.

Monday Evenings, at Eight o'clock. Second Course, on "The Application of Photography to the Production of Printing Surfaces and Pictures in Pigment." By Thomas Bolas, Esq., F.C.S.

Lecture III.—March 4th.

Line engraving on metal plates.

Lecture IV.—March 11th.

Printing of half-tone subjects from metal. Application of Asser's process. Talbot's Photo-engraving. Woodbury's methods for engraving and printing.

Lecture V.—March 18th.

Collotypic printing.

Lecture VI.—March 25th.

Other methods of producing photographs in pigment. Dusting-on method. Autotype printing.

Third Course, on "Some Researches on Putrefactive Changes, and their Results in relation to the Preservation of Animal Substances." By B.W. Richardson, Esq., M.D., F.R.S. April 8, 15; May 6, 13, 20, 27.

MEETINGS FOR THE ENSUING WEEK.

Mon..... **SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Thomas Bolas, "The Application of Photography to the Production of Printing Surfaces and Pictures in Pigment" (Lecture III.)
Farmers' Club, Caledonian Hotel, Adelphi, W.C., 5½ p.m. Mr. F. Street, "The Breeding, Rearing, and Management of Cart Horses."
Royal Institution, Albemarle-street, W., 2 p.m. General Monthly Meeting.
Society of Engineers, 6, Westminster-chambers, 7½ p.m. Mr. J. Walter Pearce, "Water Purification, Sanitary and Industrial."
Royal United Service Institution, Whitehall-yard, 8½ p.m. Mr. A. M. Silber, "Improvements in Lights for Signalling and other Naval and Military Purposes."
Medical, 11, Chandos-street, W., 7 p.m. General Meeting for Election of Officers and Council.
Victoria Institute, 10, Adelphi-terrace, W.C., 8 p.m. Rev. Dr. Rule, "Monotheism."
London Institution, Finsbury-circus, E.C., 5 p.m. Prof. Ramsay, "The Ice Age in Britain."

Tues.... Central Chamber of Agriculture (at the House of the Society of Arts), 11 a.m.
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Garrod, "The Protoplasmic Theory of Life and its Bearing on Physiology." (Lecture VIII.)
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. Bradford Leslie, "The Hoogly Floating Bridge."
Statistical, Somerset-house-terrace, Strand, W.C., 7¾ p.m. Adjourned Discussion on Mr. Mundella's Paper "What are the Conditions on which the Commercial and Manufacturing Supremacy of Great Britain depends, and is there any reason to think they have been or may be endangered?"
Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.
Biblical Archæology, 33, Bloomsbury-street, W.C., 8½ p.m. 1. Mr. Ernst de Bunsen, "Chaldeans, Pelasgians, Hyksos, and Celts." 2. Mr. Francois Lenormant, "The Assyrian and Babylonian Names for Copper and Brass."
Zoological, 11, Hanover-square, W., 8½ p.m. 1. Mr. C. Spence Bate, "The Crustaceans from the Coast of Coromandel, collected by Sir Walter Elliot, K.C.S.I." 2. Mr. A. Boucard, "Notes on some Coleoptera of the genus *Plusiotis*, with Descriptions of Three New Species from Mexico and Central America." 3. Mr. Arthur G. Butler, "A Small Collection of Lepidoptera obtained by the Rev. J. S. Whitmee, at the Ellice Islands."
Royal Horticultural, South Kensington, S.W., 11 a.m.

Wed.... **SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr. St. George Lane Fox, "An Electric Lamp-lighting System."
Geological, Burlington House, W., 8 p.m.
Entomological, 11, Chandos-street, W., 7 p.m.
Microscopical, King's College, W.C., 8 p.m.
Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.
Archæological Association, 32, Sackville-street, W., 8 p.m. 1. Mr. H. Prigg, "Excavations on West Stow Heath." 2. Mr. J. Romilly Allen, "Early Interlaced Crosses of England."
Obstetrical, 53, Berners-street, Oxford-street, W., 8 p.m.

Thur.... Royal, Burlington House, W., 8½ p.m.
Antiquaries, Burlington House, W., 8½ p.m.
Linnean, Burlington House, W., 8 p.m. 1. Dr. C. Collingwood, "New Species of Nudibranchiate Mollusca, from the Eastern Seas." 2. Mr. Thomas Meehan, "Laws Governing the Production of Seed in *Wistaria Sinensis*." 3. Dr. P. Manson, "The Development of *Filaria Sanguinis*, and the Mosquito." 4. Rev. M. G. Berkeley, "Fungi of the Arctic Expedition." 5. Dr. T. Spencer Cobbold, "The Life History of *Filaria Bancrofti*."
Chemical, Burlington House, W., 8 p.m. 1. Mr. W. H. Perkin, "The Action of Ammonia on Anthrapurpurin." 2. Mr. W. H. Perkin, "Some New Derivatives of Anisoïl." 3. Mr. G. S. Johnson, "Certain Polyiodides."
London Institution, Finsbury-circus, E.C., 7 p.m. Prof. J. Ella, "Chamber Music." (Lecture I.) Illustrated Musical Lectures.
Society for the Encouragement of the Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. Robert W. Edis, "The Decoration of Town Houses."
South London Photographic (at the House of the Society of Arts), 8 p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Chemistry of the Organic World." (Lecture VII.)

Fri....... Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Prof. Goldwin Smith, "The Influence of Geographical Circumstances on Political Character."
Astronomical, Burlington House, W., 8 p.m.
Quekett Microscopical Club, University College, W.C., 8 p.m.
Clinical, 53, Berners-street, W., 8½ p.m.
New Shakespeare Society, University College, W.C., 8 p.m. Mr. H. Courthope Bowen, "The Play of 'As you Like it.'"

Sat....... Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.
Royal Institution, Albermarle-street, W., 3 p.m. Mr. Bosworth Smith, "Carthage and the Carthaginians." (Lecture VII.)

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,320. Vol. XXVI.

FRIDAY, MARCH 8, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

The third lecture of the second course, on "The Application of Photography to the Production of Printing Surfaces and Pictures in Pigment," by Mr. Thomas Bolas, F.C.S., was delivered on Monday evening last, the 4th inst. These lectures will be published in the *Journal* during the recess.

CHEMICAL SECTION.

Thursday, February 28, 1878; Dr. Thudichum in the chair.

The Paper read was—

THE CHEMISTRY OF INFECTION, OR THE GERM THEORY OF DISEASE FROM A CHEMICAL POINT OF VIEW.

By C. T. Kingzett, F.C.S.

I was chiefly guided in the choice of my subject this evening by the remembrance that when, twelve months ago, it was my honour to describe to you the results of some of my researches in the science of chemistry—results which had led to the manufacture of a new antiseptic and disinfectant—the question was raised, What is an infectant? To-night it will be my object to give the answer to that question, so far as the present state of science enables an answer to be given. But as it will be imposible for me to enter fully into any one of the many phases presented by the study of infection, I shall endeavour rather to summarise all these, and to indicate the only safe position which may be held to-day.

When a solution of sugar is exposed to the action of healthy yeast it suffers a change; the atoms comprised in its molecule are broken up and rearranged into new forms, which are recognised as alcohol and carbonic dioxide. Glycerine and succinic acid are also formed at the expense of the sugar, but the lactic acid which generally accompanies alcoholic fermentation is considered as proved to be due to the presence of a ferment distinct from, but accompanying, the yeast. The explanation which this phenomenon has received at the hands of Pasteur—an explanation now all but universally accepted—is as follows. The fermentation alluded to is regarded as a particular instance of a biological reaction, manifesting itself as the result of a special force residing in organisms; or, in other words, fermentation is essentially "a correlative phenomenon of a vital act, beginning and ending with it."

On this hypothesis, whenever there is fermentation there is organisation, development, and multiplication of the globules of the ferment itself. The instance quoted above is by no means solitary; it is exemplary of many other changes, induced by the same or other ferment matters in media suitable for their growth and reproduction. Thus, we have the mannitic, lactic, ammoniacal, and butyric fermentations, besides many others, all of them having one feature in common, viz., the reproduction of the ferment.

Some of these processes have been studied with all the power of scientific imagination and reasoning, supplemented by the most refined methods of research available. Pasteur has described the life processes of yeast cells, and their multiplication by budding or by throwing off spores. Even their composition has been elucidated to some extent, although not to the principal extent. The ash of yeast cells consists essentially of phosphoric acid and potassium, together with a little magnesium and a trace of calcium, and this knowledge enables the operator to construct a medium in which yeast will flourish and reproduce itself. But of the character of the organic nitrogenous constituents of yeast next to nothing is known. It is certainly known that almost any albuminous substance dissolved in the medium will suffice as food to the yeast plant, but of the albuminous parts of the plant itself we have no precise information. The various conditions upon which the life, health, and even disease of yeast and other cells depend, have been beautifully elucidated by Pasteur, and it is thought that the yeast plant respires like the higher forms of animal life, and that when free oxygen is not available, it is capable of obtaining it from sugar if present. An experiment devised by Schutzenberger for demonstrating the respiratory function of yeast deserves mention here. He caused arterial blood to circulate slowly through a system of hollow tubes, constructed of thin gold-beater's skin, and immersed in a mixture of yeast diffused in fresh serum kept at 35° C. As the blood passed out at the other extremity, it was seen to be black and venous, owing to the abstraction of oxygen from it by the yeast.

One of the main points necessitating absolute establishment in such inquiries as those of Pasteur, is whether different acts of fermentation are due to different and individual ferments, and to illustrate some of the results which have been obtained in this direction, we may refer to some recent experiments of Professor Lister upon the lactic fermentation, or that change in milk which is accompanied by its coagulation and the production of lactic acid from the sugar originally contained in it. Of course by the observance of proper precautions milk may be kept in an unchanged condition quite free from acidity and curdling, but of this more anon. When, however, it is not subjected to these precautions, microscopic observation always reveals the presence of minute organisms—bacteria—in the coagulated milk. According, however, to the recent experiments of Lister, these bacteria are not uniform in character, but comprise two or more varieties, to one of which is due the special change adverted to. This was shown as follows. It was

endeavoured to estimate the number of bacteria in a given quantity of sour milk, by counting the number visible in a small measured drop placed upon a microscopic glass slide; then the milk was diluted so that a single drop would probably contain on the average one bacterium. With such measured quantities, further amounts of fresh boiled milk were inoculated, and out of five glasses so treated only one curdled, and on examination proved to contain *bacterium lactis*. Having thus succeeded in cultivating the particular bacterium in question, it was easy to inoculate any further quantities of milk. The chief points established by these results are, first, that the ferment causing the curdling was not in solution in a dissolved state, or else all the samples of milk inoculated would have curdled, but present in particles; and second, that to the one particular bacterium—*Bacterium lactis*—as Lister terms it, is due the lactic fermentation.

Liebig, who thought deeply and wrote well upon the questions under study, held somewhat different views regarding fermentation, and even the last paper written by this illustrious chemist consisted of a refutation of the later inferences of Pasteur. Of course, as regards the ultimate results of fermentation, all are agreed; but men differ in their views of the acting causes. Thus, Liebig neglected, to a certain extent, the element of life, and regarded fermentation as due to a disturbance of equilibrium, imparted to the elements of bodies by virtue of an existing change, or motion in other bodies in contact with them. But, after all, when broadly considered, the difference presented by the views held by Liebig and those of Pasteur, as generally understood, is not so great as appears at first blush. To instance our meaning, let us take the form of fermentation which is supposed by Bernard to cause the transformation of the glycogen of the liver into glucose. The change here effected is one of hydration, and, upon the germ theory, this change is supposed to be due to the influence of a special ferment present in the liver or the blood, which, while it thus acts, reproduces itself from a part of the matter influenced in the reaction. Well, Liebig would rather have viewed the change apart from a vital process; it was enough for him to perceive the conditions existing necessary to the transformation of starch into sugar, by the assimilation of the element of water; he did not see the necessity for believing the change to be due to a form of life, all that was required was the presence —the contact—of a body itself in course of a certain kind of change.

Previously, Berzelius had entertained some such notion of catalysis or contact action, but he supposed that the agent which induces the change remains itself unchanged. But such an idea as this latter one is untenable in the present state of our knowledge regarding matter and force. It may be asserted as an axiom that no substance can bring about any result among other substances without itself suffering change in some respect, be it physical or chemical. Thus, for instance, the yeast which causes alcoholic fermentation, while it is reproduced it is yet destroyed, and although the yeast assumes no constitutional part in the products of the changed sugar, some of it breaks down and dies, and undergoes a specific set of reactions, none the less real because unexplained.

Liebig, then, maintained that a body in state of change may communicate to some other bodies, with which it may come in contact, a state of change also, without being apparently altered. In fact, Liebig's views, which often receive a good deal of misrepresentation, may be expressed thus: Mechanical or other motion exerts an influence on the power which determines the state of a body. Thus, a crystal of sulphate of sodium, a speck of dust, or grain of sand, when dropped into a saturated solution, say of sulphate of sodium, may determine the entire crystallisation of the fluid. Or again, when the fulminates of silver and mercury are tickled lightly by a feather or glass rod, they suddenly explode with violence. A still better instance, and one to which Liebig seemed particularly attached, is the reaction which occurs between peroxide of hydrogen and argentic oxide; these substances, when mixed, give rise to the production of metallic silver and free oxygen, thus

$$H_2O_2 + Ag_2O = H_2O + Ag_2 + O_2$$

The peroxide of hydrogen, being unstable, is constantly undergoing decomposition from the moment of its formation, and this decomposition results in the production of water and free oxygen; immediately, therefore, that this substance comes into contact with oxide of silver, it gives to that body the same tendency to change.

Brodie explains the result differently. He says the second oxygen atom in the peroxide of hydrogen is in a different polar condition to that of the oxygen in the silver compound, and, therefore, one being negative and the other positive, they, having an attraction, combine. But this is no advance on the fact, it is merely a word explanation—another way of expressing the same fact, and it is not exempt from criticism, because it does not take into consideration the liability of peroxide of hydrogen itself to decompose.

Without multiplying examples illustrative of Liebig's views, we may say there is nothing inconsistent in their principal features and those of the doctrines now more widely held to-day. In fact, Pasteur and others have but advanced on Liebig's hypothesis. Pasteur's doctrines confine themselves to fermentative phenomena, where low forms of life are undoubtedly the active agencies, and these observations have led inevitably to speculations on germs, their nature, propagation, and functions, and their connexion with certain processes of disease. Let us now endeavour to trace out some of these subjects more minutely.

It is well known that, on exposure to the air, blood coagulates, and eventually undergoes a form of fermentation termed putrefaction, that is to say, it decomposes in a certain manner. Lister has shown, however, that blood, removed from the body, has no inherent tendency to undergo such a change, a fact substantiated by his observation that, if care be taken to keep the blood totally excluded from the air, no such decomposition occurs. Blood collected in this way will keep in the fluid state and perfectly sweet for an indefinite period. Nor is it the air itself which is competent to induce putrefactive change, but it is that something which may be, and generally is, present in the air, and which has to be removed, destroyed, or influenced so that the blood may be preserved unchanged. Contact of the blood thus kept fresh, with the most minute trace of putrified blood, is sufficient to render the whole bad and decomposed.

Some years ago, Professor Tyndall demonstrated that a ray of light passing through a dark chamber is visible only by means of the vibrating motes which float in the air bearing the light, and that, if sufficient time be allowed, these motes will subside perfectly, so that a ray of light is no longer visible in the atmosphere which previously swarmed with these particles. It is to such motes seen in the sunbeam that Pasteur and Tyndall attribute the power to start fermentation, putrefaction, and other processes in infusions of vegetable or animal origin. Some such idea as this has been more or less current in men's minds for ages; but, advancing to so recent a date as 1857, we find the following passage in a work* which then attracted considerable attention:—

"It is not improbable that the glittering motes seen in the sunbeam, when it shines through a small aperture into a dark room, consist in part of these otherwise imperceptible eggs or seeds. Light, we know, is the great and universal revelator."

Prof. Tyndall, then, advanced on this hypothesis by showing that the sunbeam owes its visibility to these motes, and, in common with Pasteur, Roberts, and many other earnest workers, he has followed up the study in some detail. The precise methods of investigation pursued by them must be learned from their own papers; here I can only summarise the results to which they have led.

The ferment matters which exist in the air may be avoided, as we have already seen, by a process of settling, or the air may be filtered through cotton-wool, or any germs therein may be destroyed by strong heating. Air purified in any of these ways is incompetent to set up those peculiar processes of putrefaction, change, and decay which inevitably happen in animal and vegetable matters exposed to air not so purified; and, if this theory be true, these matters can never ferment or putrefy, or allow of the presence of life, until contamination with previously-existing germs or life matter has been effected. This is, in fact, the theory of Biogenesis, a doctrine which has been ably expounded by Huxley, in his address to the British Association of 1871, and one which is now almost universally accepted. Its acceptance, however, is not quite universal; and, on the other side, Bastian, who has worked deeply upon the question, goes so far as to assert that he has determined the precise conditions under which urine, for instance, can develop life *de novo*. This is the doctrine of Abiogenesis. A particular instance cited by Bastian is refuted by Pasteur; but he is charged by the former investigator with having repeated the observation in a manner which would not present the identical conditions under which he (Bastian) has found life to be generated *de novo*. More recent work by Mr. Dallenger and Dr. Drysdale has revealed the fact that, while certain kinds of monads in a fully developed state are entirely destroyed by exposure to a certain temperature (140° F.), that same temperature, or even a temperature of 300° F., maintained for ten minutes is insufficient to destroy the undeveloped spores which may be present. Professor Cohn, of Breslau, has found corresponding facts to be true of the *Bacillus subtilis* and its spores. This observation has been applied in explanation of the facts stated by Bastian. In justice to this last-named observer, however, we may leave the doctrines of Biogenesis and Abiogenesis as undecided hitherto, while admitting that the mass of evidence is decidedly in favour of the truth of the former. Roberts writes:—"It seems then to be fairly established that organic matter has no inherent power of generating bacteria and no inherent power of passing into decomposition;" secondly, "that bacteria are the actual agents of decomposition;" and thirdly, that "the organisms which appear as if spontaneously in decomposing fluids, owe their origin exclusively to parent germs derived from the surrounding media."

On the basis of the work thus briefly sketched a germ theory of disease has sprung up, and it is to this matter that I more particularly wish to direct your attention.

In an address on contagium-vivum with which Dr. Roberts, of Manchester, charmed and instructed his audience at the 1877 meeting of the British Medical Association, he compared the action of yeast upon saccharine urine and the fermentative agency of *Bacillus subtilis* upon hay infusion to small-pox, and showed that the fever in a bottle resembles this disease in the following points:—(*a*) a period of incubation intervening between inoculation and the commencement of disturbance; (*b*) a succeeding period of disturbance accompanied by elevation of temperature; (*c*) a subsidence of the disturbance and a return to the normal state. Moreover, fermentation, like small-pox, may take place through direct inoculation or by fortuitous infection through the atmosphere. Dr. Roberts, however, carefully guards himself against suggesting that the enhanced temperature in the fermenting urine is a real analogue of the preternatural fever heat.

The yeast plant and *Bacillus subtilis* are the representatives of a large class of organisms which may be grouped under the generic term of *saprophytes*, and these are the kind of organisms which are found to be associated with infective inflammations and contagious fevers.

Dr. Roberts points out that the doctrine of a contagium-vivum necessitates one of two things; either it is an independent organism (a parasite), which multiplies within the body, or upon its surface, or it is a morbid cell, or mass of protoplasm detached from the diseased body, and engrafted on the healthy body. This last-cited assumption is but a modification of an old doctrine; it is indistinguishable from the views of Liebig. That chemist, proceeding upon the accepted fact that epidemic diseases can often be traced to putrefactive processes occurring in animal or vegetable matter, stated that the liability of persons to the contagion rested upon the presence in the living body of substances which offer no resistance to the cause of change in form and composition acting on it. He wrote,* "If this substance be a necessary constituent of the body, then the disease must be communicable to all persons; if it be an accidental constituent, then only those persons will be attacked by the disease in whom it is present in the proper quantity, and of the proper composition."

Liebig contested stubbornly, and with eminent reasoning, for the truth of the chemical theory over that of the parasitic theory of disease, and

* "Life: its Nature." By L. H. Grindon. 2nd edition, 1857.

* "Animal Chemistry," by Baron Liebig; translated by Gregory. Third edition. 1846.

contended that if any one contagious disease were to be explained all must be equally explicable. Thus, after writing about scabies, he goes on to say,* "If, now, we inquire what results the search after the same or similar causes in other contagious diseases has yielded, we obtain for answer that, in the contagion of small-pox, of plague, of syphilis, of scarlet fever, of measles, of typhus, of yellow fever, of dysentery, of gangrene, of hydrophobia, the most conscientious observation has not been able to detect animals, or even organised beings at all, to which the powers of propagation could be ascribed."

Even now-a-days the advocates of the germ or parasite theory admit that, as far as typhus, scarlet fever, measles, and the rest of the contagious fevers are concerned, "their connection with pathogenic organisms is as yet a matter of pure inference." (Roberts.)† On the other hand, vaccinia, small-pox, sheep-pox, diphtheria, erysipelas, and glanders are stated to have been proved to possess a virus consisting of minute micrococci.

Here it will be best to confine our attention to the three diseases of which Dr. Roberts treated in his address at Manchester, viz., septicœmia, relapsing and splenic fevers. Let us take, first of all, septicœmia. When wounds become unhealthy, the discharges become offensive, and breed organisms, and inasmuch as investigations already referred to have shown that bacteria are the acting causes of decomposition, and further, inasmuch as Dr. Burdon Sanderson and others have shown that decomposed albuminous fluids are poisonous, it is therefore concluded that septicœmia is not only due to organisms, but that such wounds as those referred to give offensive discharges, by virtue of the action of the bacteria in them, upon the surrounding albuminous parts.

Now, it has been proved, again and again, that a healthy subject cannot be infected by means of organisms alone; they cannot live on healthy surfaces or in healthy tissues, or otherwise every inspiration would carry into the blood the first seeds of all kinds of disease; these germs, then, are not the poison, but, under given conditions, by their action upon albuminous matters, they produce the poison. With this knowledge we are asked, on the germ theory, to understand as a sequence the production of septicœmia and pyœmia. Septicœmia, then, is the result of the introduction into unprotected parts of the body or wounds of organisms; these act upon the discharge, and produce the septic poison. Surely, this is no parasitic theory; it is the chemical theory of Liebig; the septic poison being that matter which Liebig would say has undergone change by contact with something else previously in course of change.

This poison seems to be particulate also, and may be separated, for instance, from decomposed meat infusions, by filtration through unglazed porcelain (Burdon-Sanderson, also Panum).‡ Such meat infusion, when introduced into the blood system of animals, produce a simple uncomplicated paroxysm of fever, beginning with a rigour which is succeeded by a rise in temperature, and concluding in defervescence and recovery, if the dose be not too great; if too great, death results. When the particulate poison, or pyrogen, as Dr. Burdon-Sanderson terms it, is first separated by filtration, as described, the filtrates are powerless to induce disease.

* Ibid. p. 209.

† See Reports on the "Life History of Contagion," by Dr. Braidwood and Mr. Vacher.

‡ Report Medical Officer, Privy Council, &c. New Series, No. viii.

These facts are so remarkable that they deserve a little more attention on our part. They are remarkable because the poison does not consist of living matter, nor is it necessarily accompanied by living matter, although it has originally been produced through the agency of bacteria. These experiments were first made by Panum, but more recently have occupied the attention of Dr. Burdon Sanderson.* He prepared his septic solution by precipitating putrilage by alcohol, re-dissolving the precipitate in water, evaporation to dryness, and re-dissolving the residue in water. These processes necessarily preclude the absence of all living matter in the product, and yet, in contrast with this fact, is the further fact that the putrilage was originally produced through the agency of bacteria in the presence of air and water.

Further, Hiller has shown that, by washing septic bacteria with pure water, they can be deprived of all toxic properties without injuring their life activity.

Relapsing Fever.—From time to time spiral organisms (*spirilla*) have been detected in the blood of patients suffering from this disease, the observation having first been made by Dr. Obermeier, of Berlin; they are found during the paroxysms, but are absent at the crises, and at the subsequent apyrexial periods. It appears that the fever is easily communicated to a healthy person by inoculation with the blood of a patient suffering from the disease, but only if the blood be taken during the paroxymal periods; hence it is concluded that the spirilla are the actual virus of relapsing fever. Ocular evidence of such germs (if such they be) is almost entirely wanting, while all attempts to cultivate them out of the body have failed. There again, therefore, we are dealing more with inferences than with facts.

Splenic Fever.—In 1855 Pollender discovered minute staff-shaped bacteria in the blood in cases of this disease, and the observation is said to have been often confirmed since. Not only is the germ found in the blood, but also in the spleen, the lymphatic glands, &c., and it is now considered by the advocates of the germ theory, that this particular bacterium is the true virus of splenic fever. It is true that the observations made by Cohn, Burdon-Sanderson, and Koch upon this subject lend some weight to the hypothesis, and Koch appears to have determined that the introduction of such germs into the blood of healthy animals brings on splenic fever. The germ is said to be identical with the *bacillus* of Cohn, but, whatever it is, it has not yet been proved that the disease is due to the germ directly, or to any altered organic matters brought about by its agency, and anything beyond what has been stated above is the merest speculation.

It is upon such grounds as those brought forward that the doctrine of a contagium vivum is thought to be established on a solid foundation. Let us put this foundation a little more to the test.

Both Dr. Sanderson and Dr. Klein maintain

* See *British Medical Journal* for December 22, 1877, and some subsequent numbers.

that, in cases of enteric fever, a luxuriant growth of micrococci may be observed in the diseased intestines. Klein, however, goes further than this, and describes certain fungic forms present in the follicles of such intestines; but what connection these may have with the disease is not precisely determined. Dr. Creighton showed that these so-called fungic structures, in the case of small-pox of sheep, supposed by Klein to consist of mycelium and gonidia, were, in reality, coagulated particles of albumen.

In a more recent paper* Dr. Creighton reports on the infectiveness of cancerous tumours, in special reference to infected lymphatic glands. In surgery, such growths are termed "malignant," and they arise in lymph glands when cancer, operating from some spot in which it has been of primary occurrence, secondarily spreads its infection to them. Dr. Creighton's Report of 1874 pointed to the conclusion that the elements of the originally diseased parts have in them a specific ferment-power, which, when carried by lymph or blood-streams to other parts, impregnates these, and the tumour grows out of the original textural type. This opinion is confirmed in the later report, and is in opposition to the idea of a germ power. In this way a part affected by tumour is supposed to consist of the same matter as before infection; only, by virtue of an induction to grow in a new way, communicated by a ferment-power, it does so.

Taking, therefore, a general survey, it cannot be fairly said that the parasitic theory, as ordinarily explained, is explained correctly. The grounds upon which this theory is based are indisputable, but there is an almost universal tendency exhibited to exceed the legitimate inferences to be made from them. This fascination has led many into error, and in it is to be found the origin of what may be called public "scares." Thus, of late years, an attempt has been made to connect the causes of typhoid fever with impure milk, containing, as it is supposed, virus matter derived from sewage or other effete substances.

The same explanation has been made in regard to recent outbreaks of scarlet fever. Quite lately† an epidemic of this kind raged at New Barnet, "and was apparently caused by infected food, in this instance presumably milk." It was endeavoured to prove this in the old way, namely, by first of all assuming the milk to be the real cause, and then showing that most of the sufferers were supplied by the same milk vendor. Such a method is as illogical as the attempt to find out the true cause is commendable. The total number of cases which happened during the two months was 140, and of these 131 were supplied with the same milk. This fact lends some plausibility, at first sight, to the theory in question, but, on further study, this disappears. The 131 cases occurred in 58 houses, but the same milk was supplied to 77 houses in which there was no fever. Further, nine cases of fever occurred in houses supplied by other milk-vendors. It is thus seen that the one particular dealer whose milk was suspected had a practical monopoly of the trade, and assuming the outbreak—without regard to its cause—to have commenced in his district, it would follow as a matter of course that the disease should be confined to that location. It hence appears there is no safe foundation, or even plausibility, for assuming that milk was here, or ever has been, the originating cause, or the propagating agent of scarlet fever or any other disease.

Let me be understood distinctly in this statement. I do not intend to convey the notion that there can be no truth in the germ theory of disease, but merely to point out that, hitherto, no absolute proof of its truth has been advanced. Even supposing, in the matter of the scarlet-fever epidemic, to which allusion has been made, it could be demonstrated that the suspected milk is capable of communicating the disease when injected into the blood of a healthy person (and this has not yet been done), it would still remain to be proved which ingredient of the milk constitutes the virus. We have seen that various forms of bacteria may be introduced into the blood with impunity, may be inspired in every breath, and conveyed into the stomach with all kinds of food, and yet no disease results; but now and then outbreaks of disease occur, and the origin is traced, with more or less probability of truth, to decomposed, putrescent matter. Surely all this does not point to a germ theory of disease, as ordinarily understood, but rather to a chemical theory like that maintained by Liebig. In this case germs are merely the concomitants of disease.

I must now ask you to follow me in the elucidation of certain fermentative changes once more. Pasteur claims to have demonstrated that every kind of fermentation is accompanied by the reproduction of the ferments, and that these in all cases consist of low forms of life. Whether, however, each kind of fermentation has its own special ferment, as for instance is the case with the lactic and alcoholic fermentations, is vague and uncertain. In reference also to putrefaction, it is considered that Pasteur has proved the same thing to be true, in spite of the contending views previously held. He, however, distinguishes two kinds of putrefaction, viz., that in which the ferment (as, for instance, the butyric ferment) produces the change without the aid of oxygen, and that in which oxygen is also essential in promoting such change. To confine ourselves for the moment to the first case.

When putrescible solutions are exposed to the air, there forms on the surface a film of bacteria mucors and mucidines, which are supposed to exclude and absorb oxygen, preventing it from penetrating into the liquids. Under the film in the liquid vibrios multiply and split up the albuminous substances into simpler products, while the bacteria and mucors excite their slow combustion into ultimate products. This is M. Pasteur's view of the phenomena of putrefaction, and it should be noticed that vibrios cannot endure the presence of oxygen; their function is the institution of initial change which is completed by the bacteria and mucors. One thing is, however, necessary for this action of the vibrios to occur, viz., the presence of water. Now, so far as has been ascertained, the first products of change above alluded to are identical with those which result in the laboratory when albuminous bodies are subjected to decomposition by hydration, that is to say, by water at high temperatures, or by boiling with such re-agents as sulphuric acid,

* Reports of the Medical Officer of the Privy Council. New series November, 1877.

† See *Practitioner*, October, 1877.

potash, or baryta. The ultimate products produced in putrefaction are those which result in the laboratory when these others are subjected to oxidising influences.

M. Donné* states that, when eggs contained in the shell are broken up by shaking, and then protected from the air by coating the shells with collodion, they still putrify in process of time, while the most scrupulous examinations will detect no form of life whatever among the products. These observations are supported by M. Béchamp. On the other hand, M. U. Gazon† concludes from an investigation that "putrefaction in eggs, whether in the presence or the absence of air, is correlative to the development of and multiplication of microscopical organisms of the family of vibriones."

These opposed statements, as also others of a like kind, should make us careful in accepting Pasteur's theory to be universally correct. Assuming, however, that it is correct, we may reduce the phenomena of putrefaction to a few issues, which in their meaning remain true, even if Pasteur's theory is ultimately disproved.

Albuminous matters have no inherent tendency to change, and they may be protected from change by suitable means; but, inasmuch as they are possessed of large molecular proportions, the impulse required to break them down into simpler products is not great; when once decomposed to this extent, under other suitable conditions, these simpler bodies are resolved into ultimate products. Take, for instance, blood serum and expose it to the air, and what happens may be assumed to be somewhat as follows:—A vibrione falls into the liquid, and by feeding in a medium suitable for its development and propagation, it thrives, and incidentally the albuminous molecule is split up, just as the liver has the power of splitting it up to make bile, or as the blood seizes oxygen in the lungs and rejects the nitrogen. This life act of the vibrione is that impulse requisite for the decomposition of the albumen, the body in change, as Liebig would put it, capable of setting another body—in this case the albumen—with which it is in contact, also in a state of change. Then other forms of microscopical life introduce themselves, and assist the decomposition similarly, the whole being supplemented by further changes induced by the presence of air and water. It is even conceivable that the very life act of the vibrione is one of hydration, that is, one which determines the assimilation by the albumen of the elements of water, just as baryta water or dilute sulphuric acid would do it also under other conditions. But whether this be so or not, the vibrione, if it be the cause of change, is only on a par with other causes of change. Further, the vibrione, if transplanted into the animal economy, will not produce disease so far as is known, yet the putrid blood serum produced by its agency will do so. What is the inference? Simply this. That germs are not *contagium* itself; they have a capability of action sufficient under given conditions to produce that *contagium*, but they themselves are not the germs of disease. I have confined my attention almost entirely to living germs; there are, however, another class of ferments, the chief characters of which may be briefly given here. Thus, we have the ferment which is capable of splitting up cane sugar (before it is fermented into alcohol) into glucose and lævulose; the emulsine of almonds, and diastase; the ptyaline of the saliva, which transforms starch into sugar, and the ferments of the spleen and pancreas which exercise a similar chemical function. These soluble ferments, or *zymases*, appear to be derivatives of albumen, but are in no sense possessed of vitality, and therefore do not reproduce themselves in the changes in which they are concerned. Moreover, in most cases, similar reactions, and leading to the same results, may be induced by many inorganic substances, such as acids and alkalies; in fact the action of soluble ferments may be expressed as a process of hydration.

Of all bodies liable to change, the most complex in constitution are the easiest to succumb to influences of this kind. Liebig writes:—*

"In fact, the larger number of single elements and atoms which have united to form a group of atoms of definite properties, the more multifarious the directions of their attractions, the smaller must be the force of attraction between any given two or three of the atoms. They oppose to the causes of change in form or composition acting on them, such as heat and chemical affinity, a far less resistance, they are far more easily altered and decomposed, than substances of a less complex composition."

Now, it has been pointed out that, so far as the products resulting from the purefaction of albumen have been identified, they are identical with those induced by processes of hydration. Unfortunately, this knowledge is not very great, although the subject has been studied by Braconnot, Erlenmeyer, Schaeffer, Habermann, O. Nasse, and more particularly, by Schutzenberger. It is impossible, in the time at my disposal, to consider this subject at all in detail, but our present knowledge may be thus summarised. The albuminous principles, though many in number, seem all to be referable to a common type, just as the various fats are, and that when these are subjected to those processes which, when applied to fats, determine their decomposition into glycerine and fatty acids, they are also decomposed first into substances few in number, but of altered properties, although not far removed from the parent molecule, while, finally, these intermediate substances are resolved into urea and amidated acids of various series. The institution, then, of putrefactive change, is simultaneous with the appearance of these products; and, some time ago, I occupied myself with many experiments upon this subject, which were necessarily cut short by unavoidable circumstances. I hope, however, in the future to be able to follow out certain indications which I then obtained, that the pursuit of this particular chemical method promises to throw much light upon the true chemistry of infection, for there can be no doubt that, sometimes at least, an infectant is a non-living product of the decomposition of albumen.

Granting this, and I believe it is indisputable, an antiseptic is a body which, by its presence, protects matters from those specific decompositions which in a collective sense we term putrefaction. While a disinfectant is, properly speaking, a substance which will take from the infectant matter, when

* Expériences sur l'Altération Spontanée des Oeufs. Compt. Rend. 57 p. 450 (1861).

† Paris, 1875. Faculté de Sciences, &c., Paris, No. 362. This is for the "Doctorat es sciences.

* "Animal Chemistry." English edition. 1857. Part 1, p. 196.

formed, its specific characters and render it harmless. It is quite immaterial, therefore, whether agents employed for these purposes be germicides or not, that is to say, the qualification of an antiseptic is not necessarily the possession by it of the power of killing germs, but rather the possession of the power of preventing these same germs or other causes from initiating those processes in decomposable matters which we term "putrefaction." Hence it was that, a year ago, when I introduced a solution to your notice for which I claimed these antiseptic and disinfecting powers, I insisted so strongly on its importance. This solution, popularly known as "Sanitas," contains camphoric acid, peroxide of hydrogen, and certain other camphoraceous ingredients; curiously enough, among these latter is a substance very similar to thymol in its character. So far as my later experiments go, I have not been able to satisfy myself whether this thymol-like body has the composition $C_{10}H_{14}O$ or $C_{10}H_{16}O$, but that it has an intimate chemical relationship to that substance, and is possessed of similar antiseptic powers, there is no doubt. This fact is the more interesting because Bucholtz has shown thymol to be a very powerful germicide, and hence it is not difficult to perceive that the presence of a similar substance in "Sanitas," together with the other constituents, sufficiently explain the antiseptic and disinfecting characters of this solution.

As is well known, this solution is produced by the action of air upon turpentine in the presence of water. In fact it consists of an aqueous solution of the aerial oxidation products of turpentine, and it, among all other available antiseptics and disinfectants, alone possesses those other characters which must be demanded of a protective agent to be employed by the mass of people,—that is to say, it is non-poisonous, and without harm to metals, clothing, and furniture. In illustration of these powers, the few specimens exhibited may be of some interest. The specimens of meat and fish contained in "Sanitas," on the one side of the table, have been so preserved perfectly good since the 19th November of last year; while the specimens on the other side were first allowed to putrefy in some degree, and have been restored to sweetness by immersion in "Sanitas."

I have also substantiated the antiseptic character of this fluid in the way already indicated, viz., by searching in matters preserved by "Sanitas" for those particular chemical products which always accompany the decomposition of albuminous substances, and so long as they have been thus preserved, these products, including tyrosine, leucine, aspartic and glutamic acid, &c., have never been detected by me. In other words, by proper disposition of this fluid, the formation of putrilage may be averted, and in so doing, the production of septic poisons or infectants is consequently avoided.

In conclusion, gentlemen, I have to thank you for the generous attention you have given to me, and to express my regret that more pressing duties have prevented me from strengthening my paper with more of that backbone of all true science— experimental evidence.

DISCUSSION.

The Chairman, in inviting discussion, said the subject presented itself in three forms. The aspect in which they would look at it was a chemical one, but there was also a medical view of the subject, and there was what he might call the general view, which might be considered by laymen, and their remarks or questions would no doubt be interesting and important.

Dr. Wright said there seemed few points for discussion, although there was a large field for thought in the various points brought forward. He hardly saw, however, on what grounds Mr. Kingzett put forth the views he seemed to hold, that the action was purely of a chemical nature as far as experimental evidence was concerned. If the solutions were entirely destitute of vibrionic or bacterial organisms, that would tend to show that the antiseptic action of the particular preservative was quite as likely to be due to a germicide action as to its power of preventing chemical changes, and he should like to ask whether the liquids placed in the presence of the decomposible bodies were found by microscopic examination to be absolutely destitute of bacteria and vibriones, or whether they swarmed with these organisms in the way in which aqueous fluids did, when brought in contact with similar substances and exposed to the air, because if living products were absent it would seem to him that the experiments hardly bore out, with the requisite degree of accuracy, the conclusion drawn, that the action was rather due to the prevention of purely chemical changes than to any germicide power in the liquid.

Mr. Page thought the paper they had just heard might be compared to a strong wind blowing away a quantity of chaff, and leaving the few grains of corn contained in it behind. This paper seemed to blow amongst the theories of medical men and chemists, but there were still a few grains of corn left, and some few facts might be brought forward which would be taken account of, before one could say that there was no proof of coincidence of germ life and disease. He wished to mention two facts which related to splenic fever, and a new disease lately investigated, called pig typhoid. Splenic fever had been investigated by Dr. Koch, who had found, on examining the spleen or blood of an animal which had died of this disease, various little rods or bacilli. If you took a drop of blood containing a few of these, and put it on the under surface of the covering glass used in microscopy, and placed around them a little aqueous humour from the eye of a living animal, as much as would go on a needle point, and then placed the glass on a suitable slide, and the whole on a warm stage, at about 30° C., and looked at it with a high power, it would be seen that each little rod would begin to elongate into filaments which would cross and interlace, they would begin to be beaded and break up, each one becoming a spore. If you now took as much of this liquid as would rest on a needle point, and treated a comparatively large dose of aqueous humour in the same way with it, the little spores would elongate into filaments, and the process would be repeated. This might be continued again and again, and it had been done, experimentally, eight times. Thus, if the original portion of infected matter, the first portion of the aqueous humour, were as 1 to 100, then the proportion at the end of the eighth process would be 1 to—he would not say how many millions. If you injected this eighth generation of bacilli into a living animal, you got unmistakeable evidence of splenic fever, and the animal would die. If, however, you took the original portion of infected fluid, and diluted it as many million times as would correspond to the same strength, no effect would be produced on the animal; but if you allowed time for the organism to grow, and injected the eighth generation, you got splenic fever, a disease which was perfectly characteristic, and about which there could be no mistake. He did not see that there could be stronger proof that either the germ caused the disease, or its presence was actually necessary. A second case had been brought before the Royal Society by Dr. Klein, who had found that in the disease

called pig typhoid, known in Ireland by the name of the "red soldier," the small bacillus was found in the blood of these animals. He had carried these germs in the same way through aqueous humour up to six generations, had re-injected them into pigs, and produced pig typhoid. So that here were two cases in which there was no mistake, and in which it seemed to be proved that a germ was absolutely necessary, and nothing else, for the disease. As to scarlet fever, typhoid, and other diseases, they had at present no tittle of experimental evidence as to any germ being necessary for disease. The case mentioned about small-pox was lacking in this proof. Dr. Klein thought he had found an organism characteristic of small-pox, but when he tried it experimentally he could not cultivate it. It was partly Dr. Klein's fault for mistaking the organism, but it was to a great extent due to the very deceptive nature of the appearances, and also partly to the botanists, to whom Dr. Klein referred, saying they were the mycelium of the fungus, which statement, of course, he readily accepted.

Dr. Mann said he did not think he had any bias either towards the germ theory or the chemical theory of disease, but for a great many years he had tried to think clearly on these points, and had read pretty well all that had been written regarding them. He confessed that the grain of corn which remained in his own mind when he had sifted as much chaff as he could away, was mainly this. There could be no question whatever that we continually found lowly organised germs associated with disease, but he could not satisfy his own mind that we had any direct evidence that the disease was caused by their presence. He quite agreed with the last speaker regarding this peculiar splenic disease, and there was no doubt with a great many of these diseases there was the presence of these low organisms, but as far as that was concerned he could not feel satisfied that that presence necessarily involved the fact that they were the cause of the disease. They had heard nothing that night about the views of a great living philosopher, whose name deserved honourable mention, Dr. Beale, in connection with the peculiar way in which possibly this association of low organisms with disease might be produced. Dr. Beale's view, which went very clearly in connection with what was called the protoplasmic theory of life, was essentially this, that whereas you have a certain amount of living organisation, separating itself into isolation in every great living creature, you might have a certain degeneration under specific diseased states, or perhaps even specific chemical states, so that instead of each separate bioplasmic mass going forward in its natural way to clothe itself with a certain organisation, and to finish its life in doing that work, it remained as a living organisation, multiplying itself without completing its work, and so producing a more lowly form, which at the same time it more rapidly multiplied. If this were so, it would be seen at once that there was an especial reason why they should be present, although they did not originate in an egg, and the special germ would not be the cause of the disease. In looking at the whole series of the actions of life he felt that chemistry played an enormous part, and would just call attention to one or two points present to his own mind. They knew that the albumen, which was at the base of all great changes of an organic kind which occurred in the living frame, was immediately produced from food, that the albuminoid foods, apart from the starches and sugars, were the great support of the living economy. Nothing was more certain than that when these foods were dissolved by digestion in the stomach, the albuminoids could not pass through the stomach and get into the blood; they were converted into peptones before they could do so; and that was the action of chemistry, it was not the work of a living organism. But there were no peptones in the blood. As soon as these soluble peptones, which were able, under the action of osmose, to get through the living membrane into the living circulating fluid, they were reconverted into albumen, and that again must be a peculiar chemical action; it could not be a vital action. It was a chemical action taking place, owing to the complex form of the molecule of albumen. Another instance of a similar kind was this. In the investing membrane of the heart there was a peculiar liquid called serum, which was intended to lubricate the outer surface of the heart to enable it to move freely in the sac containing it. One of the peculiarities of that serum was that it was very little prone to coagulation. Yet that serum was to the eye, and to all observation, essentially like the serum of the blood, which was very liable to undergo coagulation. If a single drop of the serum of the blood were put into the serum of the pericardium, it instantly coagulated the whole. That was another instance of the influence of chemistry in producing these changes. It was obvious, then, that we must allow a much larger amount of influence for the changes produced by such chemical action in the production of disease than we should be able to do in connection with the extreme theory of the living action of germs alone being essential for the production of disease. He must guard himself by saying that he did not deny there might be a large influence from lowly organisms in the production of disease, and he was quite satisfied that they were almost constantly present in many forms of disease, but still he believed it would be found that chemistry had more to do with these changes than the fashion which had lately been prevalent with regard to the germ theory would admit.

The Chairman said this was a large subject, and one of great difficulty, and it was very proper it should be brought before the Chemical Section, particularly with reference to preservative processes. The point of principal interest was no doubt that which was conveyed in the title, namely, "The Chemistry of Infection, or the Germ Theory from a Chemical Point of View." There were two difficulties which beset the question in the first instance. They dealt with the words contained in the title as if they knew what they meant, but they were in fact the very points to be investigated. For example, the word "infection." Diseases came and went, but the manner in which they did so, and the process of infection by which they arose, were unknown. Then they spoke of germs, and there again arose confusion. Some persons combined with that word the idea of a seed, which, when it came into a proper organism, became developed into a plant; others combined with it the idea of a being like an egg, which, when it came into a proper organism, brought forth a thing like an animal; and, on the other hand, shapeless ferments were also called germs, in reference to their production of disease. On that subject great caution was necessary, and he would, therefore, ask Mr. Kingzett to be very particular with regard to the definition of the word "germ." He had gone over the subject in a very able manner, and given a general view of the present state of the discussions which took place amongst men engaged in this investigation; but, at the same time, he laboured under a disadvantage produced by the peculiar state of literature in this country, namely, that a large mass of information on the subject was never brought forward, and a good deal of it was intentionally suppressed. He might quote, as an example, the work of M. Fremy, the President of the French Academy last year. He had written a very beautiful work, in which he went through the whole subject of fermentation, including several diseases, but it was never mentioned or brought forward in England, though some of the observations contained in it would refute a great many of the conclusions adopted. His experiments affected the very basis of the whole so-called germ theory of disease which was supported by Pasteur, who, after Mitscherlich, was the principal upholder of what might be called the biological theory of fermentation. He attributed fermentation proper, the transformation of sugar into alcohol and carbonic acid and a small amount of collateral products, to the life action of a corpuscle, which

he declared to be a plant, and to which he gave the name of a plant. In opposition to that, Fremy showed there were fermentations and decompositions of sugar taking place within living tissues, where there were no yeast cells whatsoever, and yet the process was as accurately performed as that in the presence of yeast cells. This might be easily proved. Take a fine, sound, sweet pear, taking care that the rind was perfectly sound, hang it up in a vessel from which you had previously removed all germs by the ordinary method of sterilisation so-called, and then displace the air by means of carbonic acid. You thereby effected the death of the pear which was previously living, and within one, two, or three days, according to the temperature, the pear would be full of alcohol, and on distilling the juice squeezed out you might get alcohol. The same thing might be done with raspberries; put them into an atmosphere of carbonic acid, and the sugar would be transformed into alcohol; but, if you investigated the tissues of the fruit you would find no yeast cells present, so that, in this case at all events, the transformation of sugar had been effected without the aid of the yeast cell. Several other experiments had been made to show that these transformations were made by fungi. For example, one which had lately been treated by Professor Lister, viz., the transformation of sugar of milk into lactic acid. The other day he had the pleasure of hearing a paper by Professor Lister on this fermentation, but he was sorry to say that on that occasion, as on the present, there was no chemistry at all in the paper or in the discussion, but they were rather going round the subject instead of directly at it. It was nothing but the record of experiments by which he had prevented milk going into the lactic acid fermentation. On the same occasion Professor Lister revoked the views he had formerly enunciated in the *Microscopical Journal*; and he must call attention to this, because the gentlemen engaged in these researches withdrew their views, or changed them, about every three or four years, so that, as Professor Henle had said, these facts of modern science had an average duration of life of four years. The views which were taken of these matters were too one-sided. One person took it entirely from the medical point of view, and he did everything with carbolic acid. Mr. Kingzett had his own remedy, and he did everything with sanitas. On the other side there were the chemists, such as Liebig and his adherents; and they would know nothing of fungi, but wanted to have chemical action only; and there was no proper differentiation of the cases which were not always comparable. Mr. Page had properly pointed out that amongst the various diseases ascribed to low, organised parasites, there were some which stood the test of time and experiment. Splenic fever, so called, was the principal and the typical one of these diseases, which seemed to be caused by a foreign body in the shape of a rod which entered the economy, multiplied, and killed. That was the important point, that splenic fever always killed. There was no case known which had recovered. It occurred only in cattle, oxen and cows, and could be produced in other animals only by artificial inoculation. This splenic fever was a severe plague in some countries; in the south of France sometimes epidemics of it went over the country and ruined many agriculturists. It was first discovered by M. Davaine, a French microscopist. The discussions on it lately had been very lively in the French Academy, and Pasteur maintained that these rod-like bodies killed by abstracting the oxygen from the blood in which they multiplied, and that the animal actually died from suffocation. But there were other equally eminent men who maintained that the suffocation, which was evident, was caused by these rods multiplying indefinitely, and entirely obstructing the little blood-vessels of the lungs. But even so, all the phenomena were not explained, because Professor Virchow, who investigated the great epidemic of splenic fever amongst the deer belonging to the Emperor of Germany at Berlin, found that the number of rods in their tissues was so small that neither by the one theory nor the other could the death of the animal be accounted for. Then came the chemical point of view, taken up by Professor Kohn. He said no doubt there are in these diseases these forms of plants or animals, but they do not kill by either of the methods already referred to, but by excreting a poison which exercises a deleterious effect on the animal body. They were thus brought opposite the chemical theory of Liebig, only they had, as it were, built a bridge to it, consisting of these germs or bacteria which produced the poisonous ingredient. Putrilage, which by the way was a new word, but perhaps a useful one, consisted probably of a mixture of extracts of an alkaloidal nature. Some of the details Mr. Kingzett had brought forward were interesting, but were not capable of being closely investigated. For example, Lister's experiment on the blood and its non-coagulation, when collected without the presence of air, did not stand the test of investigation at all. It was twenty years since Dr. Richardson and himself had made a great many of these experiments now brought forward as novelties, amongst them the collection of blood in tubes previously exhausted, and in the Physiological Laboratory at Breslau there was blood which had been kept for seven years in this way. But, on investigation, it was found that the blood underwent a very remarkable change, and its constituents which before were colloidal became crystallisable. So that when you took this blood out of the tube and shook it you got crystals, which from blood not so preserved you did not obtain. Mr. Kingzett said he did not believe in the transfer of typhoid fever by means of milk, but there he thought he had gone too far, for he believed the transfer of typhoid fever by the agency, for example, of sewage infected with typhoid excretions, had been very well proved; in fact, a certain dairy company, in whose business this sad misfortune occurred, had themselves admitted that their milk had been the vehicle by means of which typhoid fever had been transferred from a farm somewhere up the Thames Valley to Marylebone, and had there caused about 450 cases of typhoid fever. But, after all, that did not show that typhoid fever was caused by a fungus. They only knew what they knew before, namely, that the disease might be produced from something that came from a previous case of disease. They should, therefore, not disbelieve everything that was said, but subject everything to fair criticism. He had seen varioloid epidemics, which spread over many square miles of country with many villages and towns; these cases were not true variola, but variola modified by vaccination. The manner in which it spread was quite unintelligible. The insidiousness, the refinement it exercised in its propagation, was very wonderful. On the other hand they knew that cow-pox did not so travel, at least with the human subject, it must be transferred by means of a lancet, and even then it frequently failed; it did not go from one human subject to another through the air, it required inoculation. No doubt the active matter of variola and cow-pox was particulate, that is to say, an insoluble, not a dissolved matter, but whether it was a fungus or not had not been proved, in fact, the question had not been approached. If it were proved that it was a fungus, they could not resist the proof, but at present the proof was not forthcoming. Diseases divided themselves into two great classes, those which were always fatal, or which never heal by themselves, and those you could say, as a general rule, might be caused by fungi. There were other diseases which heal of themselves within a given period of time, and, with regard to them, there was a great intellectual difficulty in assuming that they could be caused by either a plant or an animal which could reproduce itself in the economy. The views of the medical profession were, he thought, now clearing themselves in that

direction; that diseases which might be caused by fungi were always fatal, whilst those which might recover by themselves could not at present be viewed as being caused by these plants or animals. The question was no doubt beset with such difficulties that they must be very patient even with errors. As Mr. Page had pointed out, Dr. Klein had seen certain things which he believed were a mycelium. He submitted them to the most eminent botanists in this country, and they all were of opinion that this was actually a mycelium, that is to say, a network of microscopical fungi. Thereby, of course, Dr. Klein was thrown off his guard. He himself, from the drawings submitted, should never have believed them to be mycelium, because he had seen these formations so many times and knew they were nothing but fibrine in a particular state. This only showed how patient they should be with investigators who saw things for the first time, and should remember how difficult it was even to get the material for investigation, for example, to go into a small-pox hospital, and get the proper materials and know what you have to investigate, and then to produce those high powers of the microscope which were necessary, for these supposed plants were no doubt so very minute as to go near the margin of the visible, and even beyond the margin, for they were now informed that many of these things were invisible. In fact, they were invited to believe that that was a germ which could germinate whether they saw it or not. And here he must say that the theory of Abiogenesis, that is to say, of genesis *de novo*, had just as much argument for its truth as the theory of invisible germs, for where there was nothing and something appeared you might say there was nothing with just the same amount of justice as another man who saw nothing said there was something there before which he could not see. The argument on each side seemed to him equally strong, or if they preferred it, equally weak. He had heard Professor Lister say, if there was a large yeast cell, and then a bacterium, which was so small in proportion, why should there not be things which, in relation to the bacterium, were as small as that was in relation to the yeast cell? But that was the argument of "why not?" and the why not argument lent itself to all kinds of uses. All this seemed to him an invitation to them to keep their eyes open, and not to swear too much by individuals. The very doctrine now taught by Lister, in King's College, had been preached by chemists since 1864, and he had preached it himself in the hospitals at Leipsic, in that year. He there and then showed that infection adhered to the forceps, and plasters, and ointment pots, and to every bandage they had in the place, and many patients who came into the hospital became infected with pyæmia; the result was that they took all the wounded and put them in barracks in the yard. He had sent a report to the *British Medical Association Journal*, and gave a definition of what was called surgical cleanliness. The practice of surgical cleanliness, therefore, did not require the germ theory; but might also be produced by the practice of what might be called the chemical theory. They were equally effective, as could be shown by countless examples. For instance, the hospital in Bingen, maintained by the International Society for Aid to the Sick and Wounded in 1870, was certainly a pattern hospital in this respect. There was no pyæmia at all; in 54 major operations, some very severe, not a single case of pyæmia occurred. In the same grounds there were a number of tents full of typhoid patients, but such was the chemical antiseptic protection that not a case of infection occurred. If there was any argument in the absence of infection, here was a case; if you kept things absolutely clean from a chemical point of view, whether there were germs or not, it did not matter, the germs had no chance. That was the advantage of Mr. Kingzett's sanitas, that whether it killed germs or not, it prevented them from being active. Here, you came to the general definition of what fermentation was, and that was very well exhibited in M. Fremy's work:—"The letting loose of certain powers which are potentially contained in animal cells." He proved that by most remarkable experiments, and he thought it was the most complete definition which had yet been given. He would not go into the distinction between shapeless and shaped ferments, and there were many other points which they must leave to the future to be determined.

Mr. Kingzett said he really had very little to answer, but merely to explain away a few apparent inconsistencies and misunderstandings. Dr. Wright asked whether or not Sanitas killed organisms which would be present if it had not been added. He did not know much about this question, but several physiologists to whom he had given specimens said it was a germicide. He had shown that it contained a body like thymol, which was known to be capable of killing these so-called germs. Whether it killed germs or not be did not care, so long as it prevented meat or fish undergoing putrefaction, and prevented the formation of septic poisons. He had recently given some specimens to Professor Schiff and other scientific gentlemen in Geneva, who had arranged to make some experiments with Sanitas, and he hoped, before long, to publish the results. Mr. Page had rather misunderstood him, because he had plainly stated that, in 1855, Pollender discovered certain staff-shaped bacteria in the blood, and this same bacteria had been found in the spleen. This particular growth had been found by many experimenters when introduced into the blood to produce splenic fever. All he argued was that it had not been proved that the germ, or whatever it was, was the actual cause of the disease. When a bacterium fell into albumen, it would split up the albumen and produce a poison which was capable of producing septicœmia; but the germs themselves would not produce it. Therefore, how was it proved that this particular bacterium, which produced splenic fever, was the actual agent of its production? He admitted it was the first cause, but you did not know it was the actual agent. How did you know it did not split up the albumen in the blood and produce the identical poison which the bacteria would produce in albumen out of the body? Hence, whether it produced it directly or indirectly, it was only on a par with the other changes of chemical agency. Liebig said he did not deny that a living creature might produce a chemical reaction, only that the vital action was a chemical action; just as when a man inhaled so much air into the lungs, the blood abstracted the oxygen and set free the nitrogen, and just as the blood coursing through the liver gave rise to bile, he contended it was a chemical reaction. When food was taken into the stomach it was broken down and re-arranged, but there was no doubt it was a chemical reaction. Liebig argued to his death day that Pasteur's theory was not the true answer; it had not been proved that you could not start these very chemical reactions by other than vital agencies, and that was all he contended. He did not deny that these things produced disease, but contended it had not been proved that the disease was due to their direct agency. He had a great respect for Dr. Beale's theory, and quite believed in it; there was no doubt that the formation of bone and tissue of all kinds proceeded from a protoplasmic nucleus which had a kind of ferment power of searching out from the pabulum which surrounded it those elements which were essential for building up the particular structure in which it existed. Dr. Creighton had shown that if you introduced foreign agencies which were not ordinarily at work, you could produce a departure from the textural type, so that pathology was the degeneration of physiology. With regard to the chairman's remarks on the question of infection, he was quite willing to admit that we were dealing with very indefinite terms. But here was a fact. You might take a solution of blood, or pure albumen, and let it putrefy, and a septic poison was produced which might

be separated by filtration into two parts, and it would be found that the filtrate would not produce disease, whilst the matter separated from it would. For all practical purposes, that supplied you with the proof of what an infectant was—it isolated the infectant. You could only say that the infectant was caused by the splitting up of albumen by hydration. As to the introduction of typhoid fever by milk, he thought he must hold his ground. It was quite possible to frighten a milk dealer so much that he would confess he had been the man through whose agency the fever had spread. The principal question, however, he wished to bring forward was that, so far as chemistry had been directed to this subject, every process of fermentation and putrefaction was shown to be synonymous with the process of hydration. They knew the chemical formula of albumen to be $C_{72}H_{112}N_{18}SO_{22}$, and that, by certain chemical agencies, you could split it up and produce other substances, such as urea, &c., and a body which had this formula, $C_{64}H_{128}N_{14}O_{32}$; and, if you continued the process further, this would split up into other bodies. Chemists should rather aim at working out these problems in detail, and so, by and by, they would be able to determine completely the other side of the equation. When they had done that, chemically speaking, they would have explained the action of certain forms of life which were sometimes called germs of disease.

The Chairman then proposed a vote of thanks to Mr. Kingzett, which was carried unanimously.

THIRTEENTH ORDINARY MEETING.

Wednesday, March 6th, 1878; Prof. JOHN TYNDALL, LL.D., D.C.L., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Barker, Stephen, Calthorpe Fields, Edgbaston, Birmingham.
Coles, Oakley, 5, Upper Wimpole-street, W.
Hadland, Miss S., Milton-mount College, Milton-on-Thames, Kent.
Kennedy, E., M.D., 24, Queensberry-place, S.W., and Belgard-castle, Clondalkin, Dublin.
Lee, William, Summerfield, Prestwich, Manchester.
Lo Fong Loh, C.I.C.S., 7, Weymouth-street, Portland-place, W.
Patteson, Henry, 6, Anson-road, Victoria-park, Manchester.

The following candidates were balloted for and duly elected members of the Society:—

Armstrong, Thomas, Highfield-bank, Urmston, near Manchester.
Christie, The Worshipful Richard Copley, M.A., Chancellor of the Diocese of Manchester, Uplands, Prestwich, Manchester.
Dees, James Gibson, Whitehaven.
Forwood, Arthur Bower, Mayor of Liverpool.
Grimsey, Benjamin Page, Stoke-lodge, Ipswich.
Knuttel, G., Delft, Holland.
Stürmer, Miss Frances von, 25, Gloucester-road, S.W.

AND AS HONORARY CORRESPONDING MEMBER.

De Ayala, His Excellency Don Ramon Lopez, Havanna, Cuba.

The paper read was—

AUTOMATIC GAS-LIGHTING.

By St. George Lane Fox.

Arranged along the walls of this theatre there are several gas-burners connected with the gas mains, and controlled by an electrical apparatus I have on the table. I would ask you to imagine that each one of these lights or burners represents a street lamp, removed from me at a considerable distance, and some thirty or forty yards apart. Now, it is evident that if the double operation of lighting and extinguishing these lamps is to be performed by me, I should have to go to each separate lamp twice, so as physically to operate on them, or else I must have some means of action at a distance; and this latter process is commonly spoken of as automatic gas-lighting. Now, looking over the various forms of action at a distance at our disposal, it will be seen that light, heat, and sound must be set aside as inapplicable to the purpose, there remains, therefore, mechanical action, either direct or otherwise, and electricity.

When the matter was first taken up some years ago, and it was known that an electric spark or a fine platinum wire, rendered incandescent by the electric current, would ignite a stream of gas, it was naturally thought that there would be no difficulty in applying this agent to the lighting of street-lamps, and many large buildings were fitted up with appliances by which a current of high tension electricity was conveyed to the burner by means of insulated wires.

The sunlight in this theatre, for example, is lit by this system, and the Albert-hall, the Assembly-rooms in Paris, and various other places are similarly treated; in all these cases the gas is turned on and off at the main. This system is extremely convenient, as sometimes in very large halls the lights are so placed as to be almost inaccessible for the ordinary process of lighting. When, however, it was attempted to convey this high tension current to any great distance, the greatest difficulty arose as to the insulation of the wires; moreover, this method would be only available for producing one, or at the most two or three sparks in a single circuit, and the idea was therefore abandoned. It was also found out that to produce any large number of incandescent platinum wires in circuits of great length, and accordingly high resistance, was also impracticable. In these two systems there is of course no means provided for turning gas on and off, which is an absolute necessity for any automatic system to be rendered useful. Accordingly, the idea of lighting street-lamps by electricity was, for the time, put aside.

We now come to mechanical action. It has occurred to a great many people that, by increasing or diminishing the pressure of the gas in the mains, it would be possible to actuate an apparatus in each lamp so as to turn on the gas and shut it off, and, by having a small jet burning all day by the side of the principal burner, the issuing gas would be ignited. But, in combination with this pneumatic action, various other methods suggested themselves for producing ignition; such, for instance, as setting up an electric current by raising the level of a liquid so as to bring it in connection with opposing metallic surfaces, thereby forming a galvanic couple. And, in some instances, the heat produced by chemical action has been made use of. After very numerous trials in this direction, I think I may safely say this system has also been abandoned, not only because this alteration of pressure would be a source of serious inconvenience and even danger

to the consumer, but also because the construction of the gas mains does not admit of any material increase in the pressure at a distance from the works. A scheme has been proposed in which pipes are laid down to all the lamps, so that, by increasing the pressure and exhausting, a double action can be obtained, so as to turn on and extinguish the gas, but by this means a separate electric system had to be employed for producing the flame. I will not trouble you further with details of these inventions, but will proceed at once to explain the method by which I propose to apply and utilise electricity alone as the agent for lighting and extinguishing gas. In the first place, then, I supply every lamp with an apparatus such as you see it there; next the lamps must be connected with an insulated conductor, so that, starting from a central station, a wire would travel through each of these machines and back again to the station. I propose that several of these circuits, each connecting and controlling 200 or 300 lamps, should proceed or radiate from a central station, so that from one point several thousand lamps could be operated upon almost instantaneously.

The method by which I have succeeded in producing the ignition of the gas at a considerable distance, and at numerous points, is by supplying each lamp with a small induction coil, so that the primary wires of each one of these induction coils forms part of the circuit, so in fact as to preserve without a break the metallic continuity of the line. When first the idea suggested itself to me, I connected together two or three of these coils with a battery of six large bichromate cells, and placed in the circuit a private telegraph line of about three miles in length; I joined up the circuit by an ordinary vibrating contact breaker and condenser of tinfoil and paraffined paper, similar to that used in Rhumkorff coil. On setting the battery in action, and making and breaking contact, I was unable to obtain the faintest indication of a secondary discharge, I accordingly used a very much more powerful battery composed of fifty-five very large Bunsen cells; with this enormously powerful current I was just able to feel a small shock from the secondary wires, but could not obtain sufficient spark for ignition of the gas, accordingly, I considered that this method was not practicable, when it occurred to me that in reality the amount of work to be done, in producing a number of these small electric sparks, was extremely minute, although at the same time requiring to be produced almost instantaneously. Now, the amount of work which an electric battery will produce is dependent on the time during which action continues, and in a single instant, or say, the thousandth part of a second, the actual amount of power available is naturally extremely small, and I thought that if I could by any means accumulate this power for a short time, and then bring it suddenly to bear upon the circuit, the desired result would be obtained. As an illustration of what I mean, supposing I was desirous of breaking some extremely hard substance, such as corundum, and I had at my disposal nothing but a very small hammer, it would be quite possible that I should bring an indefinite number of strokes to bear upon this substance without producing any result, while, by accumulating all the energy expended in these blows into one tremendous thump I could reduce this hard substance to fragments. I have here upon the table the apparatus by which I have succeeded in accumulating the electric current and storing it up into this condenser or electric reservoir, which is composed of glass plates and tin-foil laid side by side alternately.

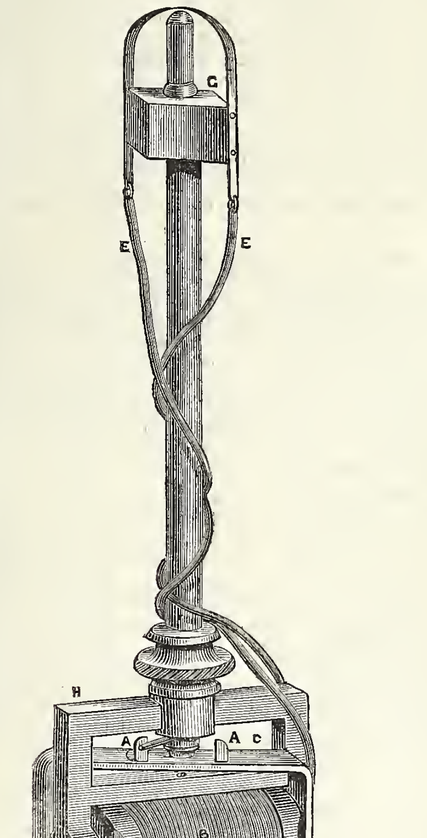
The condenser, however, is not charged direct by the battery, but the current is made to work this Rhumkorff induction coil, from which there is derived a current having an enormously increased electro-motive force, and it is this electricity that is stored up in the condenser.

Having charged the condenser in this fashion, the whole of the electricity is at once sent through the line, and produces, as I have said, most extraordinary results. So much, then, for the lighting of the gas. The process of turning on and off the gas, although involving many important details, is very simple. I make use of the soft iron core which runs through the centre of the coil to produce a reciprocating horizontal motion of a permanent horse-shoe magnet, suspended on needle points just above the coil. The soft iron core with the primary coil is in fact an electro-magnet, which can be magnetised so as to render its poles reversible at pleasure; the magnets are carried in a small metal frame, having a passage through it for the gas to pass to the burner at the top, and being provided with a stop-cock, or valve, which is actuated by the reciprocating magnet. The whole of this apparatus is enclosed in an air-tight metallic case, which measures about $2\frac{1}{2}$ inches high by $2\frac{1}{2}$ wide, and is screwed on to the supply pipe in the lamp; the insulated conductor or line wire being carried down the interior of the lamp-post and laid under ground, except of course where an overhead line is admissible. The turning of the gas on and off is accomplished by opening and closing what may be termed an electric needle-tap. The plug of this needle-tap is cylindrical, and about a quarter of an inch in diameter, and is carried in a socket, which it fits rather loosely. It is made to turn in this socket by the action of the reciprocating magnet, a couple of studs, on which are brought into contact with a small pin or lever connected with the plug, and forming, in fact, the handle of the stop-cock. The annular space between the plug and the socket (which is about one-thousandth part of an inch) is filled with some liquid, which is retained by capillary attraction between the two surfaces, the joint being thus rendered perfectly gas-tight. The oil of bitter almonds or glycerine are both well adapted for the purpose, on account of their non-oxidisable character, and from the power they possess of resisting the action of very low temperatures. It will be seen that a special feature in the apparatus is the introduction of a fixed core, which can be magnetised, so as to render its poles reversible at pleasure, and in conjunction with it a moveable magnet, the polarity of which is permanent. An electric current sent either forwards or backwards for a few seconds, will turn the gas on or off in every lamp in the circuit according to the direction of the current.

I have been experimenting for a long time on the subject, and although I have met with considerable difficulties, I think I am now in a position to state that there is no reason why the system should not

be applicable to the lighting of the lamps in any large town. By the kindness of the directors of the Gas Light and Coke Company I have been able to test the practical working of the scheme on a somewhat extensive scale, and several lamps have now been in operation for about a year.

I should now like to make a few remarks on the way in which I propose to put the system into practical operation. As I said, there would be for any district of say two or three thousand lamps a central station, from which the wires would proceed in every direction, so as to command a number of distinct circuits; all that is necessary to have at the central station would be a battery of some sort, or what I would very much prefer, a



Description of Illustration.

C. Coil. F. Frame. M. Magnet. B B. Wires from secondary coil. E. Ebonite or wood collar. W W. Wires from induction coil. S. Socket. G. Stop-cock.

magneto-inductor, that is, a machine for producing an electric current by mechanical means. As no solutions are used for generating the current, there will be none to replace, and it is always ready for use, so that by turning a handle a powerful current is produced. I believe that these machines have been adopted very largely on the German railways, for releasing clockwork used in signalling, or wherever a rather powerful current is required for a very short length of time. When I say powerful, I mean as compared with the ordinary telegraph currents, which are sometimes not more than the thousandth part of a veber. By means of a switch and a commutator, the electric current from this machine can be directed so as to operate separately on each one of the circuits, and by this means turn the gas on or off. Let us suppose the gas turned on, the next process is of course to light it, this is effected as I have said by sending a discharge from the condenser. A condenser such as I have here would, I believe, have a sufficient capacity for lighting about a hundred lamps. It is extremely simple in construction. It is constructed of alternate metallic plates, with an insulator or dielectric between them; the conducting surfaces in this case are of tinfoil, and the dielectric of crown glass. A number of plates are used so as to get a large surface in a small space. The simplest form of condenser is that known as the detonating plane, and consists simply of two sheets of tinfoil, pasted on opposite sides of a glass pipe. The coil used for charging the condenser need not give more than about three-quarters of an inch spark in the air. The discharge, like the current, will of course have to be sent through each circuit separately, and this is also done by means of the switch arrangement. The chief objection that has been raised to any system of lighting street lamps by electricity, is that the conducting wires would be liable to be cut, and so interrupt the continuity of the line. But I am sure that this is only an imaginary difficulty, as it would be a very simple matter to discover the place of rupture, and patch it up temporarily, almost as quickly as it would take to light a single lamp by the present process. For instance, a double earth could be made at the point of rupture so as to divide the circuit into two; besides which it is extremely improbable that more than one circuit would be out of order at the same moment, and just at the time of lighting or extinguishing. I have here a sample of an underground cable specially prepared for me by Messrs. Siemens, Bros.; it consists of a core composed of one solid copper wire insulated with two layers of gutta-percha served with tarred jute, and sheathed with 14 B.B. galvanised iron wires, then served with one layer of tarred jute yarn and two coatings of compound; the diameter of this cable is about half an inch. It will of course be laid in the ground without any additional protection, being in itself very strong and durable. Cables very similar to this one in construction have been very extensively laid in Germany for the underground telegraph lines. I am, however, of opinion that an overhead line well out of reach, that is to say, about 16 feet from the ground, and supported as they are now in Pall Mall, would answer well for any small districts where it would be thought too expensive to lay an underground cable.

DISCUSSION.

Mr. Dibley having taken some interest in the lighting of the district in which he lived, was under the impression that Mr. Fox would have given some information relative to the cost of this system, and what saving would be effected by it, because that was really the vital point in the matter. He understood the proposal was to light the gas in the manner shown by a suspended wire, or by a cable carried under the streets; but the carrying on of an experiment at the Fulham Gas Works would be very different to doing it in a public highway, where he feared there would be an opportunity offered to boys and mischievous persons to play practical jokes if the wires were carried overhead. Again, at the present time, when rates were so high, vestries would be very indisposed to entertain any new scheme, unless they could see that it would be the means of saving money. He hoped, therefore, the lecturer would state the cost of laying cables—which he believed was the only practical method of carrying out the plan—and also the cost of maintenance for lighting 10,000 lamps. Also what supervision would be required, and if it was likely that the gas companies would be induced, by the adoption of this system, to decrease the price at present paid for gas per lamp. An experiment might be very successful, but unless it was likely to be economical there would be no chance of its success.

Mr. F. J. Bramwell, C.E., F.R.S., said they had just heard one of those conservative and economical speeches which were the bane of every inventor in England. There was a gentleman who had come with one of the most ingenious inventions he had ever met with, who had brought it before the Society for the Encouragement of Arts, Manufactures, and Commerce, after having tried it on a considerable scale for a year, and now desired to try it in public; and, instead of receiving the encouragement he deserved, he was met with the objection that, unless he could say at the outset what was to be saved by it, he was not to be listened to. Gas lighting had originated in England, but it was left for the Continentals to show us that, though it required a man to go up a ladder to light an oil lamp in England (for, on the Continent, the lamp was lowered), a gas lamp might be lit by a light on the top of a pole, and that plan had been adopted for 12 years in Paris before it was followed in London. He had not the slightest doubt that, if this invention were taken up—as he hoped it would be—and worked for a year, it would then receive the support of the London Vestries. Passing from that point, he desired to say a few words in commendation of this most excellent invention. What was the problem Mr. Fox had set himself? First, how to turn the gas on; having got it turned on, how to light it; and, lastly, having got it lighted, how to put it out. These were not very easy things to do from a distance. Dealing with a large number of lamps, he said that the enormous power required seemed to beat him, but that when he thought of it he found that the requirement was enormous only for a short time, and that if, therefore, he could utilise for a period a small power and store it up, as a man stored up his small income till quarter-day, so that then, without having a large income, he could pay his rent when it was due, this difficulty would be got over. Then, as to turning the gas on and off, he had shown a most ingenious method, by which he had the means of producing a reverse motion in the permanent magnet which turned it on, and having done so he was not compelled to keep the power on during the whole time the gas was burning, as if it had to counteract a spring, which would turn it off, but could, by one action, turn it on and leave it burning until he was pleased to reverse the current to turn it off. Then there was the difficulty of the gas-taps, in which—made as well as they could be—there was always considerable friction. He appeared to have directed his attention to this in a most ingenious way. He did not attempt to get power enough to turn on a tap with ever so small a friction, but used a weighted lever to perform a rapid rotation, and when it had performed a considerable rotation, and got a momentum, and was at the point of greatest attraction, then it acted on the tap, when it would be able to overcome the small friction which there was, and which was besides reduced to a minimum, by using glycerine or oil of almonds, which would not become sticky or evaporate, but would bear a pressure of eight-tenths of an inch, though the real pressure was probably not more than two-tenths after the governor was interposed between the pipe and the burner. This showed how one invention grew out of another, for he did not think it would have been possible to use this invention if gas lamps were not fitted with governors, because there would be the difficulty of suiting the taps to the various pressures; but as lamps were now fitted with governors they were rendered independent of the pressure in the main, provided only there was pressure enough, and the taps could be turned fully on, so that every lamp would burn with a proper size of flame and no more. Having in this way turned on the tap and lighted it, by a reverse current he turned it off again. But, having devised all this, it was rather hard that Mr. Fox should be met with the discouragement that unless he could say what would be the saving when it was thoroughly perfected, they did not care to listen to him.

Mr. Hale said the matter of expenditure required to be gone into, and he did not consider that the first speaker had made his remarks in any carping spirit. Something of this kind had been experimented upon thirty or forty years ago. He had no doubt Mr. Fox would show that the very fact of being able to instantly light and put out the gas would result in a very large saving. It appeared to him that the difficulty would be to light lamps three or four miles from the gasometer, and if this could be accomplished, he had no doubt the invention would be successful.

Mr. Bennett said he was also a member of a Vestry, and he should like to know how many lamps could be lighted by one battery. In his parish the lamps were placed 50 yards apart, and there were 3,300 of them. It would be a great saving and a great convenience to the public if the proposed system could be carried out. They were now paying 18s. per lamp for lighting, cleaning, and painting. It appeared to him that if this method could be adopted they could on the average save one hour's gas, or one-twelfth of the whole, and as they paid something like £16,000 a-year for gas, it would be a considerable amount. They paid, with extras, £4 5s., £4 7s. 6d., £4 12s. 6d., and £4 14s. 6d. per lamp, because they had four companies in their district, and each had a different price and system. He did not care about disarrangements, for they had them every night. If such a thing could be carried out there would be a large saving every year. and the public would be better pleased, because it was evident that in such a system they would have an equal flame in every lamp, and he was quite sure that if this condition could be fulfilled the invention would be supported.

Mr. David Chadwick, M.P., said he had been connected for 20 or 30 years with the lighting of a large corporate town, and being treasurer of the Gas Works and Lighting Commissioners, had had considerable experience in the matter; he had also had an opportunity of seeing the experiments at the Fulham Gas Works, which were very satisfactory. Although he agreed with what Mr. Bramwell had said, he could not help coming back to the point that, after all, the value of an invention lay in its practical application and in its economy. They might pass a unanimous vote of thanks to Mr. Fox for his perseverance and ingenuity, even though the invention were not an economy, and no one would refuse to join in

giving so young a man encouragement, so that he might go on to further and greater achievements. He was not, however, going to occupy time by praising the inventor, but would take up the question put by the first speaker. The test after all was this, whether the invention would not only benefit the general public, but prove a saving to the pockets of the ratepayers. He had made a little calculation on the figures given by Mr. Bennett, and would give the results. It appeared that in his parish they paid from £3 to £3 10s. per lamp. The time would come, he hoped, when they would have a united management and united gas works, and when the public would be the possessors of the gas and water, but it was not so yet. They had then to demonstrate to the gas company that by the application of this invention they could, under their present contract, in economical parishes light the gas and turn it off at fixed times, and by so doing effect a saving. He should say that at least one hour per day could be saved on each gas lamp in the metropolis. What did that mean? Taking it at one-twelfth of the whole, one-twelfth of £3 was 5s. But, then, there was the expense of lighting. He had sometimes been awakened in the middle of night, when the moon was shining brightly, to know if the gas lamps might be turned off, and at other times, when the moon did not shine when it ought to, the gas wanted lighting unexpectedly. Now it cost about 14s. per lamp for this attention, so that altogether there was a saving of nearly £1 per lamp. The next question was, what would it cost to effect that saving? As far as he knew, the system was comparatively inexpensive; he did not want to betray secrets, but he believed the invention could be applied and maintained for something like 30s. per lamp. If it could be done for 30s. or 40s., what would it cost the parish? They could borrow the money at four per cent., and he believed a contract could be made by which at least one half of the £1 per lamp would be saved to the parishes. If this could be done in every large parish in England, the total saving would be enormous. He believed Mr. Fox was willing to place himself in the hands of any one who would take up the invention, and he was glad to know that there was going to be a public exhibition of it in Pall-mall, where he would publicly light and extinguish the whole of the lamps as often as the authorities might require.

Mr. Strode asked whether during the time the lamps were in operation at Fulham Gas Works, the tap or valve which turned on the gas was ever found to stick. That appeared to him to be the weak point, and he should like to know what amount of force could be exerted on the lever if it did stick. He thought the continued action of the gas on the oil must tend to thicken it. He saw no other difficulty, and the saving must be enormous.

Mr. Price thought if this invention were carried out throughout London, and as they had heard, mischievous boys by tampering with the wires might prevent the lighting of the gas, it would be a very serious thing, because the whole metropolis might be left in darkness, and to guard against this it would be necessary to keep a large staff of men ready to light the lamps in the ordinary way.

Mr. Chadwick said it was not intended practically to carry the wires overhead, where they would be exposed to danger, but underground.

Mr. Perry F. Nursey had had an opportunity of inspecting the working of this invention at Fulham at the close of last year. He went with the intention to find fault with it if he could, but the result of his observations was entirely satisfactory. Not content with that, he made many inquiries of Mr. McMinn, the company's engineer, who assured him that he had watched it most carefully, and had no fault to find with it. His attention was particularly directed to the point just raised about the sticking of the valves, and these he found had given no trouble at all. No practical man would think of employing overhead wires for a system of telegraphy.

Mr. Preece thought he could at once dispose of the objections raised with regard to the difficulty of maintaining the wires in working order, and the probability of their being destroyed by naughty little boys or other mischievous persons. At the present moment there were in the streets of London 5,000 miles of wire, which were carrying the thoughts and wishes of the people to all parts of the world, and the notion of any wire ever being disturbed had never entered the head of any practical telegraphist. More than that, he had just returned from visiting a country where there were as many wires over ground as there were in London under ground; for, throughout the United States, in all the principal towns the telegraph wires were carried through the streets, and no one ever dreamed of the wires being damaged. More than that, there was a town called Providence, where the whole of the street lamps were lit by electricity, and the wires were carried over head. It was there where the gas was turned on and off, as Mr. Fox had described, by pneumatic pressure, electricity being used only to light it. He had not time to go and see it, but he made several inquiries, and he found that opinion was very much in favour of the system as being economical. As to the practical difficulties, when it was considered that every morning in this country cannon were fired in Newcastle, Edinburgh, Swansea, and other places, when time-balls were dropped here, there, and every-where, and when the Greenwich current was distributed over some 100,000 miles of wire, he did not think any telegraphist would feel the least alarm when asked to devise a system of lighting a few thousand lamps in that little village called London.

Mr. W. King, as the engineer to the largest provincial gas company in the kingdom, said the subject was a very interesting one to him. He trusted that in any remarks he might make with regard to economy, he would not be considered as in any way reflecting on the skill and ingenuity of the inventor. He should greatly lament if that institution were the means of checking instead of advancing inventions, but still, as had been said, the value of every invention depended on the way in which it could be practically applied. He might also say, in reply to a remark made by Mr. Bramwell, that the town of Liverpool might claim the priority of using a pole for lighting street lamps, over Paris. With regard to the lighting of lamps by electricity, the case would of course be ultimately considered, and there were two points to which he should have to direct Mr. Fox's attention. One was, the cleansing and repairing of lamps, which would necessitate the employment of a considerable staff, and secondly, the employment of a staff to meet contingencies which would arise from time to time.

The Chairman said he remembered, some years ago, Mr. Fox coming to him with a certain scheme, which, at that time, he considered an ideal one. He had certain notions in his head, which he put forward with a great deal of ardour. He could see there were many difficulties in his way, and he could only say to him, "My dear friend, you will have to work it out." He did not expect then to hear to-night so practical a response to his recommendation, for it would be agreed by all present that, as far as the application of scientific principles and considerable mechanical skill were concerned, he had really given a very satisfactory practical answer to his recommendation. He had followed this matter, of course, as a man of science, and he had been much pleased at the clearness and soundness of the views enunciated by Mr. Fox. His employment of scientific means was perfectly judicious, and, as far as he could see, he was perfect master of the agent he was operating with. He did not think he had any reason to leave the room with the idea

that the meeting had not been disposed to give every encouragement to him, for there had been no remarks made which could be construed as anything like a feeling of carping criticism. Even the gentleman who first spoke evidently did so most good-naturedly, and his views certainly had their value. It gave him great pleasure to notice the evident desire there was to encourage a young inventor, which had been evinced by the meeting. It must have been very satisfactory to Mr. Fox to hear the observations of the hon. member for Macclesfield, and those of other speakers, especially those of so able a man in practical matters as Mr. Preece. Mr. McMinn's name had been mentioned, and he must say that it had been his privilege to make that gentleman's acquaintance, and a more intelligent and sympathising aid Mr. Fox could not have had; and his testimony was, to his mind, of very great weight in his favour. All he had to say was that Mr. Fox had every reason to quit the room with his courage strengthened, and with a determination to proceed to a successful issue. And he trusted that as he proceeded farther and farther, he would make it more clear to the community at large that he had really struck upon a useful invention, and that, by and bye, the scientific application would be justified by the economic results.

Mr. Fox, in reply, said that almost every objection raised had been answered by some kind friend. A question had been raised as to the working of a large number of lamps at a distance from the works, and he might mention that he had been able to light a large number of lamps included in a circuit having a resistance of about 300 ohms, which would represent 30 miles of ordinary telegraph wire.

The Chairman having proposed a vote of thanks to Mr. Fox,

Sir Antonio Brady, in seconding the motion, said that as president of the Inventors' Institute, he had listened with intense interest to the paper and discussion, and he was all the more interested for being a director of a large gas company. They had immense losses by reason of the imperfect way in which they had to light and put out the lamps, far more than had been assumed to-night; and he was much pleased to hear that the mechanical contrivance had been so much improved since he last heard of the invention. On reading the patent, he found there were several grave objections, which now seemed to have been removed. With regard to the cutting of the wires, he did not know that it was proposed to light the whole of London by one machine, but only a certain number of lights in one district; and he could see no possible objection to that. As an old member of the Society, he should have been exceedingly sorry to hear any discouragement offered to a young inventor, and should have protested against it, had it occurred.

The resolution was carried unanimously.

NOTICES.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at eight o'clock.

March 13.—Further Remarks on Lightning Rods." By Dr. R. J. Mann, F.R.A.S., Vice-Pres. Meteorological Society.

Indian Section.

Friday evenings at eight o'clock.

March 15.—"The Colonisation of Hill Districts in India." By Lieut.-General McMurdo, C.B. Edwin Chadwick, Esq., C.B., will preside.

Cantor Lectures.

Monday Evenings, at Eight o'clock. Second Course, on "The Application of Photography to the Production of Printing Surfaces and Pictures in Pigment." By Thomas Bolas, Esq., F.C.S.

Lecture IV.—March 11th.

Printing of half-tone subjects from metal. Application of Asser's process. Talbot's Photo-engraving. Woodbury's methods for engraving and printing.

MEETINGS FOR THE ENSUING WEEK.

Mon.....SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Thomas Bolas, "The Application of Photography to the Production of Printing Surfaces and Pictures in Pigment." (Lecture IV.)
Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Captain F. J. O. Evans, R.N., "The Magnetism of the Earth."
Medical, 11, Chandos-street, W., 8.30 p.m.
London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Francis Darwin, "The Analogies of Plant and Animal Life."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Garrod, "The Protoplasmic Theory of Life and its Bearing on Physiology." (Lecture IX.)
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Captain Douglas Galton, "Railway Appliances at the Philadelphia Exhibition."
Photographic, 5A, Pall-mall East, S.W., 8 p.m.
Anthropological Institute, 4, St. Martin's-place, W.C., Prof. A. Graham Bell, "The Natural Language of the Deaf and Dumb."

Wed....SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Dr. R. J. Mann, "Further Remarks on Lightning Rods."
East India Association, 20, Great George-street, S.W., 3 p.m. Mr. W. Wedderburn, "The Panchàyat a Remedy for Agrarian Disorders in India."
Graphic, University College, W.C., 8 p.m.
Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m. Annual Meeting.
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 pm.

Thur....Royal, Burlington House, W., 8½ p.m.
Antiquaries, Burlington House, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 7 p.m. Prof. J. Ruskin (Slade Professor of Fine Art, Oxford), "The Distinctive Powers of the Art of Sculpture." (Lecture I.)
Royal Institution, Albermarle-street, W., 3 p.m. Prof. Dewar, "The Chemistry of the Organic World." (Lecture VIII.)
Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.
Royal Historical, 11, Chandos-street, W., 8 p.m. 1. Mr. G. Laurence Gomme, "Historical Manuscript Commission." No. 1, "The Anglo-Saxon Period." 2. Dr. R. Sandon Gutteridge, "Ancient and Modern Political History."
Royal Society Club, Willis's Rooms, St. James's, S.W., 6 p m.
Mathematical, 22, Albemarle-street, W., 8 p.m. 1. Prof. Clifford, "Bence's and La Place's Functions." 2. Prof. J. Clerk-Maxwell, "The Electrical Capacity of a long narrow Cylinder, and of a Disc of sensible thickness."

Fri.......SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Indian Section). Lieut.-General McMurdo, "The Colonisation of Hill Districts in India."
Royal United Service Institution, Whitehall-yard, S.W. 3 p.m. Captain P. H. Colomb, R.N., "The True Basis for the Rule of the Road at Sea."
Royal Institution, Albemarle-street, W., 2 p.m. Weekly Meeting. 9 p.m. Lord Rayleigh, "The Explanation of certain Acoustical Phenomena."
Philological, University College, W.C., 8 p.m. Mr. H. Sweet, "Swedish Dialects."
Royal College of Physicians, Pall-mall East, S.W., 5 p.m. (Gulstonian Lectures). Dr. Ferrier, "The Localisation of Cerebral Disease." (Lecture I.)

Sat.......Physical Science Schools, South Kensington, S.W., 3 p.m. 1. Mr. W. Millar, "The Transmission of Sound through Copper Wires." 2 Mr. G. W. von Tunzelmann, "Thermo-electric Currents in Wires subjected to Mechanical Strain."
Royal Institution, Albermarle-street, W., 3 p.m. Rev. W. Houghton, "Natural History of the Ancients." (Lecture I.)

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,321. Vol. XXVI.

FRIDAY, MARCH 15, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

The fourth lecture of the second course, on "The Application of Photography to the Production of Printing Surfaces and Pictures in Pigment," by Mr. Thomas Bolas, F.C.S., was delivered on Monday evening last, the 11th inst. These lectures will be published in the *Journal* during the recess.

UNION OF INSTITUTIONS.

The following Institutions have been received into Union since the last announcement:—

Holloway College, Spencer-road, Loraine-road, Holloway, N.

Milton-mount College, Milton-on-Thames, near Gravesend, Kent.

DOMESTIC ECONOMY CONGRESS.

The Executive Committee met at the Town-hall Manchester, on the 1st March, the Bishop of Manchester in the chair, and resolved that the Congress should be opened on Wednesday, 26th June next. The following is the programme as adopted by the Executive Committee:—

The second yearly Congress on Domestic Economy and Elementary Education, will be held, by the kind permission of the Worshipful the Mayor of Manchester, at the Town-hall, Manchester, in connection with the educational institutions of Cheshire and Lancashire, on Wednesday, 26th, Thursday, 27th, and Friday, 28th June, 1878.

President of the Congress—His Grace the Duke of Westminster, K.G., Eaton-hall, Chester.

Chairman of the General Local Committee (representing the Counties of Cheshire and Lancashire)—The Worshipful the Mayor of Manchester.

Ladies' Committee — President, the Countess of Derby, Knowsley, Prescot; with others elected by the General Local and Ladies' Committees.

Executive Committee—Chairman, the Bishop of Manchester, Bishop's-court, Higher Broughton; and eight others elected by the General Local Committee.

Finance Committee—Chairman and Treasurer, Oliver Heywood, Esq.; and four others elected by the General Local Committee.

Secretary of the Society of Arts—P. Le Neve Foster, Esq., M.A.

Honorary Secretaries of the Congress—William Felton Peel, Esq., Shenstone-house, Broughton-park, Manchester; and Mrs. Eason Wilkinson, Greenhays, Manchester.

Assistant-Secretary of the Congress—Mr. F. Scott, Accountant, 100, King-street, Manchester.

The General Local Committee consists of about 190 Members of the Society of Arts resident in the counties of Cheshire and Lancashire, together with Members of the Congress elected by the General Local Committee, and being local residents distinguished for their interest in education in Cheshire and Lancashire.

PROGRAMME OF PROCEEDINGS.

Sanctioned by the Council of the Society of Arts, subject to modification to be made to meet local circumstances.

Conversazione.

The Congress will be opened with a Conversazione on the evening of Wednesday, 26th June.

Papers.

(*a*.) Papers will be prepared, printed, and circulated not less than a week before the Congress, to be used during the Congress.

(*b*.) The papers must not exceed in length, without special permission, about 2,000 words, and must be preceded by a short argument.

(*c*.) The papers must have strict reference to the modes of teaching children the several subjects in elementary schools, and must not be treatises on the general subject.

(*d*.) Persons desirous of preparing papers in any of the following subjects should inform the Secretary of the Society of Arts, John-street, Adelphi, London, W.C., or the Assistant-Secretary to the Congress, Mr. F. Scott, 100, King-street, Manchester, as soon as possible, and the papers themselves should be sent in as early as possible, and before 15th May, 1878, at latest.

Subjects of Papers.

1. Methods of teaching the subjects of Domestic Economy in public elementary schools; also in secondary schools. Use of diagrams, models, and objects
2. Mode of Inspection and Administration of Government Grant for teaching Domestic Economy.
3. Amendments of the Education Code necessary for enabling Domestic Economy to be effectively taught in elementary schools.
4. Establishment of a National College for Domestic Economy.
5. Importance of Female Inspectors.
6. Training of Domestic Servants, both male and female.
7. Health and Sickness—Temperance.
8. The Dwelling—Warming and Ventilation.
9. Thrift.
10. Needlework—Clothing and its materials.
11. Food and Cookery.
12. Cleanliness—Washing.

Regulations as to Proceedings.

1. The subjects will be discussed in the order laid down in the programme to be issued hereafter.

2. Each speech will be limited to *ten minutes* on each separate head specified in the programme.

3. The papers, which, as far as practicable, will be printed and published before the Conference, will not (except under special circumstances, at the discretion of the Chairman) be read, but each writer of a paper may state the *argument* of it, in addition to any speech within ten minutes. Writers of papers may speak immediately

after they have introduced their subjects, or at the close of the discussion.

4. Speakers will be called upon in the order in which their names are sent up to the Chairman on the subject.

Membership of the Congress.

Members of the Society of Arts, and delegates from the Institutions in Union with the Society, are admitted free to all meetings of the Congress. Other persons will be admitted to the *conversazione* and meetings as members of the Congress by purchase of a ticket, price 10s. 6d., and will be presented with a copy of the papers printed before the Congress.

Tickets of Admission.

Application for tickets, information, &c., should be addressed to the Assistant-Secretary of the Congress, Mr. F. Scott, 100, King-street, Manchester, or No. 4, Committee-room, at the Town-hall, Manchester.

The business of the Congress will be commenced on Thursday morning, the 27th June, 1878, at 10 o'clock. The sittings will be held as follows:—Mornings—From 10 till half-past one. Afternoons—From two till half-past five.

Publisher to the Congress—Edwin Slater, 16, St. Anne-square, Manchester, of whom may be obtained tickets for the Congress, price 10s. 6d., also the report of the Birmingham Congress; price 2s. 6d. to persons presenting their tickets of membership; 5s. to others.

FOURTEENTH ORDINARY MEETING.

Wednesday, March 13th, 1878; Lord Alfred S. Churchill, Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Bourke, W. Roston, 37, Devonshire-road, N.
McKerrow, John Begg Norcliffe, Broughton-park, Salford.
White, J. T., 4, Clarendon-place, Hyde-park-gardens, W.
Williams, C. J., 29, Albert square, Clapham, S.W.
Woodford, Rev. A. T. A., 10, Upper Porchester-street, W.
Young, H., 50, Grosvenor-road, S.W.

The following candidates were balloted for and duly elected members of the Society:—

Currey, Charles, 38, Treguntcr-road, South Kensington, S.W.
Gilles, William Charles, 14 and 15, Paternoster-square, E.C.
Hawes, Colonel Herbert, East India United Service Club, 14, St. James's-square, S.W.
Remington, George, Jun., 19, Ashchurch-grove, Shepherd's-bush, W.
Walmsley, Francis Harrison (Mayor of Salford), Higher Broughton, Manchester.

The paper read was—

FURTHER REMARKS CONCERNING THE LIGHTNING-ROD.

By Robert James Mann, M.D., F.R.A.S., &c.

In some of the sciences nature itself performs the work of experiment upon a scale, and with a completeness that human ingenuity and skill can in no way approach. The task of investigation, then, mainly resolves itself into the careful and close observation of natural phenomena as they occur. This is especially the case in regard to the branch of scientific inquiry which concerns itself with the behaviour of lightning. The electrician can deal experiementally with electrical effects on a miniature scale in the study and laboratory. But he must adopt the patient and tentative process of watching for opportunity, and waiting upon events, if he aspire to interpret the secrets of electrical action, as this is manifested upon the large scale in the thunder-storm and in lightning. It is my purpose, in this communication, to draw attention to some opportunities of this class that have come under my own notice since I last addressed the Society of Arts upon the theme.* I have very recently, through the consideration of the Government of India, which has done me the honour to circulate through its Public Works Department, a communication that I made to the Meteorological Society, upon "Some Practical Points connected with the Construction of Lightning Conductors," in May, 1875,† received a detailed account of an accident which occurred, from the effects of lightning, at a double storeyed barrack in the Royal Artillery lines at Barrackpore, on the 31st of July last. The injury effected by the lightning was very slight, but the case is nevertheless one which involves a considerable amount of scientific interest, on account of some of the peculiarities which it illustrates.

In reference to this case of accident, the superintending engineer of the Presidency Command reports the occurrence to the Inspector General of Military Works, and furnishes the information which is contained, in a compressed form, in the following notes:—The building appears to have consisted of a main central portion higher than the rest, surrounded on three sides with verandah rooms of a lower elevation. Lightning conductors were fixed at each side of the higher building. A tapering iron rod, an inch and a half in diameter at the base, was carried up on each side five feet above the parapet of the higher central part, or dormitory. The bottom of this terminal rod was led to a short piece of cast-iron water-pipe, 5 in. in diameter, which, in its turn, was connected with a similar water-pipe, running down the outside wall of the verandah, by a band of iron 4 in. wide and three-eighths of an inch thick. This band was carried across the flat roof of the verandah compartment, which appears to have been composed of some kind of cement, termed "masonry" in the report. The down pipe of the verandah is connected with the earth, at its bottom, by means of a similar piece of bar iron, inserted 18 in. into the ground, and there terminated in three radiating chains 8 ft. long, with links an inch and a-half in diameter. This arrangement is shown in the accompanying sketch (Fig. 1), in which it will be observed that the lightning-rod, raised 5 ft. above the parapet of the main roof, is connected with the iron rain-pipe of the dormitory by joint 1, and that, from the bottom of this, at joint 2, an iron bar runs across the flat roof of the verandah to joint 3, where it is connected with the rain-pipe of the verandah. From the bottom of this rain-pipe, at joint 4, the iron bar runs down into the earth.

On the evening of July 31st, a thunderstorm occurred in the neighbourhood of this barrack,

* See *Journal of the Society of Arts*, vol. xxiii., page 528, April 28, 1875.

† See "Quarterly Journal of the Meteorological Society," vol. ii., page 417.

and there were several vivid flashes of lightning and loud peals of thunder. At half-past 7 o'clock one peal was louder than the rest, and simultaneously with it a flash of lightning struck, first

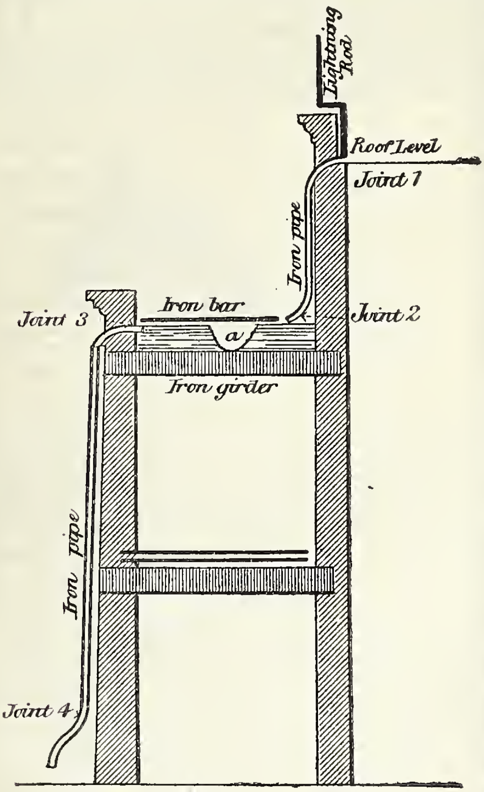


Fig: 1

the iron bar crossing the roof of the verandah, and then passed from it through the masonry of the roof to the iron girder, lying immediately beneath, and chipping out a hollow excavation in the masonry, between the bar and the girder at *a*, 9 inches in diameter, and 2 inches deep. This is all the mischief that was caused. There was no trace of mechanical violence anywhere else. The lightning-rod and water-pipe above the transverse bar furnished no trace whatever of the passage of any electrical force. The question in this instance therefore arose, why it was that the lightning-rod had been avoided by the lightning, and why the iron bar at the lower elevation, and professedly a part of the same conducting system, had been struck in its stead?

A trial of the conducting capacity of the several parts of this system, designed for protection, was made immediately afterwards by the superintending engineer, by a Wheatstone's bridge, and the cause of the accident was directly revealed. It was found that the resistance to the transmission of an electric current between the point of the lightning-rod and the iron bar at *a* amounted to 11,000 ohms. The resistance at the point 3 was 3,200 ohms; and the resistance from the top of the verandah rain-pipe at 3, through the joint 4 to the earth, was only 196 ohms. In consequence of the inefficient condition of joint 1, the proper terminal of the rod was of no avail, and the lightning had therefore taken the easier course through the large iron girder to the verandah water-pipe, avoiding the faulty joint 3, with its 3,200 ohms of resistance, and leaping at once to the pipe from the outer end of the girder.

There are several interesting considerations of some practical moment suggested by this accident. In the first place it strikingly manifests the objection to the employment of the ordinary metallic structures and portions of a building for the purposes of protection from lightning, unless the most scrupulous and exhaustive care is taken to see that the various joinings of the different pieces of the metallic line are in an efficient state of continuity. Joints are always very questionable matters in a lightning-rod. Then, in the next place, this case still more forcibly illustrates the great importance of testing the efficiency of lightning-rods by the actual examination of their resistance to electrical currents. If this examination had not been made in this instance, nothing whatever would ever have been known of the reason of the inefficiency of the points, and yet again it is equally clear that if the examination had been made before the accident instead of after it, it would have been known from the first that the point, with the broken gaps at joint 1, could not possibly be expected to perform its work, and was, therefore, only a dangerous pretence.

Another deduction, which comes naturally out from this case, is the fact that a lightning-rod with an objectionable earth-contact effected through a chain, and with a resistance as large as 196 ohms between the verandah and the water-pipe and the earth, did nevertheless serve upon the occasion of this accident as efficient protection. The conductor was unquestionably struck by lightning in considerable force, but below the spot made in the masonry at *a*, it was harmlessly conducted to the ground. There was no trace of damage of any kind along this part of the route. This fact, however, must only be taken for what it is worth. It must on no account be interpreted as indicating that an earth-contact with a resistance of 196 ohms would have been sufficient in every case. But it is confirmatory of numerous other instances which are on record, and which seem to prove that, very commonly conductors that are below the standard of desirable, and easily attainable, perfection, do nevertheless perform serviceable work.

There is yet again one other consideration of great practical moment that arises out of this case. It will be remembered, that in the communication which I made to the Society of Arts three years ago, I dwelt with some persistence upon the view of M. Callaud, that, with a faulty lightning-rod the connection of metallic masses within the building, such as outside balconies, with the general system of conduction, may be a source of imminent danger. The Barrackpore accident strikingly illustrates the correctness of this view. If a soldier had chanced to be standing upon the terraced roof of the verandah, just above *a*, at the time of the accident, he would assuredly have been killed by the lightning making an intermediate step through him on

its way to the girder and the water-pipe of the verandah, and if there had been no water-pipe and efficient earth-contact beneath, his chances of immunity and escape would have been very materially increased. On the other hand, if the conductor itself had been of thorough efficiency from point to earth; if there had been good points above, ample and jointless connection through an altogether continuous rod, and a large and free earth-contact in the place of the faulty arrangement of chains, the man standing on the terrace would have been absolutely safe. The whole question of the expediency of supplementary connections with metallic masses resolves itself into the larger consideration of the arrangement of the conductor.

Yet once again, this instructive instance of accident from lightning assuredly points to the need, to which I have already drawn attention upon some other occasions, of a reconsideration of the dogma that lightning is not "attracted," as the phrase goes, by lightning-rods. That dogma is true or false according as it is understood. It was, in the first instance, advanced by scientific men to remove a popular prejudice against the employment of conductors. In a well-constructed lightning-rod, performing its intended office perfectly, there is no "attraction" for the lightning in any sense. The tension of the earth and cloud are alike diminished by the continuous discharge that is kept up, whether from cloud or earth, through the system of points, and the probability of a lightning stroke, or flash, is diminished in the proportion of that discharge. Where, however, in consequence either of the bluntness or insufficiency of the points in the air-terminal, or of deficient capacity in the earth-contact, this is not the case, it can hardly be held that a lightning flash is not more likely to fall where there is a ready metallic path provided for its conveyance to the earth than where such facility is not supplied. In the Barrackpore case the masonry of the terrace roof at *a* was struck, and the dormitory rain-pipe above *a* was not touched; yet the only difference between the iron girder beneath *a* and the dormitory water-pipe above was that the resistance in the one case was 196 ohms, and in the other case 11,000 ohms. The immunity of the higher water-pipe was obviously due to the absence of any freely open route from it to the earth. But this surely must be taken, as a mere matter of untechnical common sense, to mean something very like the lower route having been preferred to the upper one. In other words, if the verandah water-pipe had been as faulty in its conducting capacity and earth-contact as the higher stretch of the conductor, there would have been, very possibly, no lightning stroke at all. To that extent, and in that sense, the lightning-rod below the joint 3 did, by its own efficiency, determine—or, in other words, "attract"—the discharge.

I now pass on from the Barrackpore accident to another case of injury from lightning that seems to me to be worthy of a passing word of comment. A short time ago I received a communication from an old and very highly esteemed friend in Natal, detailing a fatal accident from lightning with admirable exactness and precision, and asking of me an explanation of the result. The accident occurred in the upland region of the colony, to the house of a Dutch farmer named Buys. The house stands in a region that is famous for its thunder storms, and is placed upon a ridge with a high mountain near at hand towards the north-east. A small water stream, which descends from the lower slopes of the hills, divides to pass close to each end of the building, which is a low one-storied structure, covered with a galvanised iron roof, and having the general form which is shown in the accompanying sketch (Fig. 2). There is a chimney

Fig: 2

at the east end, and there are three windows and a door in the south front. During a severe thunder storm this house was struck by lightning, and it was conceived that the stroke fell upon three parts of the roof—at the top of the gable opposite to the chimney, beneath *a* and at the two parts of the lower edge of roof marked *c*—because there were very obvious traces of mechanical violence there. An iron bar over the ridge at *a* was bent three inches towards the north by the discharge, and at the lower ridge, *c*, over the window, there were two semi-circular patches of the metal scarred and turned white by oxidation. The glass in the window, *f*, was shattered to pieces. Between that window and the next, in the inside of the room, there was a wall-cupboard which was injured. There was a crack in the beam over the door stained blue. At the time of the flash Mrs. Buys was entering the door, and she was struck upon the head, and fell dead outwards, with marks of burning along the skin of the neck, spine, and lower extremities. The boot upon one of her feet was ripped to pieces. A child standing close in front of her was scorched on the back of his head, and insensible for an hour, but then recovered. A second child was also hurt, but less severely. A large brass pan, with copper hooks and an iron handle, hanging in the kitchen, to which the door gives access, was battered in at one side.

The great puzzle which seems to have occurred in reference to this case was mainly due to the fact that the house was furnished with two lightning conductors. There was a lightning conductor at each end consisting of a half inch rope of galvanised iron wire as shown at *a* and *b*. These were surmounted in due form by pointed rods, and were in contact with the iron roof. Yet this terrible accident occured. My friend's communication to me on the subject concluded in these words: "I hope you will write me your opinion about this lightning affair at Buys' house, and how to meet such a case." I had no difficulty in complying with this request, for my friend had sent his son to the place of the accident, and this gentleman had drawn the most elaborate and careful

sketch of the house and its surroundings, the one in fact which I hold in my hand. On referring to this sketch, in connection with the character of the roof, I find the following very lucid statement, which is, of course, itself the very sufficient explanation of the whole affair. "The house has a galvanised iron roof; with wire rope conductors half an inch in diameter at each end—*both broken off some time ago, half way down, and the lower half gone.*" I need scarcely say that under these circumstances the lightning was bound to do exactly what it did. It did not, however, strike the house in three situations, as was conceived. It struck the lightning conductor at *a*, then passed along the galvanised roof to the discoloured patches at *c*, and from there leaped through the shattered window and the person of Mrs. Buys to the earth. The poor lady, indeed, was at the time herself really the earth-terminal of the faulty conductors. I allude to this case because it is a type of very numerous instances of an entirely similar kind that have come under my notice. In this particular instance there would have been danger without the two imperfect lightning conductors, because of the galvanised iron roof. But the danger was materially increased by the extension upwards of the terminal rods; and, indeed, under any circumstances the iron roof would have held the place of an imperfect conductor without earth connection. The case is, therefore, a typical, although greatly exaggerated, instance of the danger of imperfect and inefficient conductors.

In the same communication which brought me this report of the accident at Buys' house, my correspondent gave me the details of another serious accident which occurred in a mountainous locality in Natal, with which I am quite familiar, at nearly the same time. The situation of the accident is where the high road from the port to the capital passes over the highest intervening ground. The storm came from the Umlazi River, and crossed the high road on its way to the Inanda location, at the foot of the Inchanga Hill, between it, and what is known as the Halfway-house. As it passed the high-road, a flash of lightning killed sixteen natives, and five oxen. My friend saw the five oxen all lying together. Instances of this kind are of frequent occurrence in the wild open districts of the colony. In such cases the animals are, no doubt, killed simultaneously by the breadth of the discharge. It sometimes happens that a very large circular area of the grass is found charred by the lightning. The lightning falls as a vast blow on the whole space, and does not pass from animal to animal, and as it would do through the links of a transmitting chain.

One other instance of an accident from lightning of a surpassingly interesting character, which has come under my notice since my previous communication to the Society of Arts, I must, of necessity, allude to, on account of the admirable and instructive account of it which has been given by the hero, if I may so venture to term him, of the incident. My friend, Mr. D. Pidgeon, was residing with his family, at the time of the accident, in a house standing upon the sea cliffs in the parish of Paignton, about three miles from Torquay. The house is placed upon a bold headland projecting out into Torbay. A flag-staff had, at some former time, been erected by the coast guard, on a small plot before the door. This consisted of a strong mast, 50 feet high, with a metallic vane on the top. It had no lightning-rod, but was stayed about half way, or 25 feet from the ground, by four galvanised iron guy ropes, which were terminated about 12 inches from the ground in half-inch iron chains, the links of which were so corroded in places that the iron was reduced to something like an eighth of an inch in diameter. The chains were anchored in the ground in a very dry red sandstone conglomerate. On the afternoon of February 25th, 1855, a drift of heavy scud set in from the sea, as Mr. Pidgeon with his wife and son came up to the flag-staff on their return from the shore. Mrs. Pidgeon and her son had just taken shelter from a burst of hail near the door of the house, about 10 feet from one of the mooring chains, and Mr. Pidgeon himself was standing about 20 feet away from them and 10 feet from another of the mooring chains, looking out at the drifting scud seawards, when a flash of lightning struck the flag-staff and splintered into fragments the portion of it which extended from the vane to the attachment of the guy ropes. At the instant of the flash, Mrs. Pidgeon was felled to the ground, and Mr. Pidgeon and his son received a shock; neither of the party were made quite unconscious, but neither of them were aware of any flash, and neither of them knew anything about the falling of the shattered mast. Mrs. Pidgeon conceived that she had been fired at, and Mr. Pidgeon and his son thought that they had received a blow from some "persons unknown." The son had afterwards a distinct remembrance of an electric shock in his legs. For a short interval neither Mr. Pidgeon nor his son could speak, and they had not the slightest idea of there having been any discharge of lightning until they had recovered, sufficiently to notice the wreck of the mast scattered around. Mrs. Pidgeon was marked upon the skin by red radiating lines, and there was especially one which evidently corresponded with the position of the iron bolt of the door, against which that lady was leaning at the time of the stroke.

At the point where the mooring chains entered the gravel path of the ground, pit-like depressions or craters were formed, and the soil was so far loosened that a walking-stick could be thrust into them for about 12 inches. Shallow trenches or tracks were also opened out round the base of the path, and of these one ran some 30 feet to an iron garden roller, and a little beyond. Three of the mooring chains were broken, about 20 of the links altogether having been snapped across, and very curiously the parts of the links where the fractures occurred were, in no instance, those where the thickness of the iron had been reduced by corrosion. Some of the broken links were above, and some below the surface of the ground. The broken surfaces were bright and crystallised, and furnished no traces of heating or fusion.

This accident, it will be observed, very strikingly illustrates what happens when lightning is discharged into the earth by a faulty or insufficient earth-contact. It bursts into the ground by a violent impact, and spreads itself out in all directions through the resisting substance, which it encounters in doing so. The chains offered substantial resistance at each link, ran but a short

distance into the ground, and the soil which they there came into communication with was non-conducting and dry. This was unmistakeably proved by the one long trench ploughed up to the iron roller, through the surface gravel. That would not have been found if the ground into which the mooring chains entered had been well and deeply saturated with moisture.

Mr. and Mrs. Pidgeon, and their son, took their part in the general dispersion of the discharge, and, happily for them, but a very small portion fell to their share. Their escape from instant death was due to this fact. Some small part of the discharge, on account of the general dryness and great resistance of the ground, passed up from it through Mrs. Pidgeon, and through the iron bolts, to the door, and thence diffused itself into the various structures of the house. This, no doubt, was the correct interpretation of the marks upon the skin.

The fracture of the numerous links of the mooring chain was a very remarkable feature in this accident. Unfortunately, I only saw one of the links that were so broken, but I have no doubt that this effect was the result of the mechanical strain caused when the discharge passed through the guy ropes. The links were literally torn asunder by the shortening of the ropes, incident upon the molecular disturbance set up in them during the transmission of the electric force.

In my previous communication on the protection of buildings from lightning, I made a passing allusion to the method of defence employed in the Hotel de Ville, at Brussels, by Prof. Melsens.* Since that time I have had the pleasure of examining the whole of that work, under the kind and intelligent guidance of M. Melsens himself, and I have received from him, only within the last few days, the elaborately illustrated work which he has just published as the official account of his labour, and which I am exceedingly glad to have thus early opportunity of bringing under the notice of the Society.†

Professor Melsens has for a long time advocated the system of employing numerous rods of small size, rather than one rod of large size, in establishing a protection from lightning. He virtually aims at covering the building which is to be protected by a sort of metallic net, thrown broadcast over the structure and furnished with numerous points projecting into the air above, and with numerous earth-contacts, or rootlets, diving down into the soil beneath. He contends that the usually accepted view, that a well appointed conductor protects a conical space the diameter of whose base is twice the height of the conductor, is not worthy of implicit trust, that numerous accidents have in reality occurred within that limit, and that the only absolute protection that can be devised is the plan of covering the entire structure with intermeshed lines of defence. At the time of my visit to Brussels, the Professor had in his laboratory two little birds whose sphere of duty it was to demonstrate the absolute reliability of the network plan. One of the birds in performing this task was placed in a special cage of netted metallic wire, and successive shocks from a battery of fifteen large Leyden jars were then flashed through the cage without any injurious effect upon the inmate. The feathered experimentalist went through this ordeal for my enlightenment with the utmost *sang froid*, as if he had quite realised the soundness of the doctrine that was illustrated by the play of the mimic lightning about his head.

Professor Melsens' views have been elaborately carried into effect at the Hotel de Ville, at Brussels, and it is hardly too much to say that this noble building is in all probability one of the most perfectly protected structures in the world, so far as possible accident from lightning is concerned. The hotel consists of a principal building in front, surmounted by a pinnacled turret and spire, 90 metres, or 297 feet high, and carrying upon its summit a gilt statue of Saint Michael flourishing a drawn sword, and standing upon Satan, represented in the form of a horned dragon turned upon its back. There are four galleries ornamented with corner pinnacles upon this spire, and the main block of building beneath has also six spire-crowned subordinate turrets, and three parapetted gables, projecting above the roof. Behind the main block of building there is a square enclosure, or inner court yard, formed by an addition running out from the front block, so as to constitute the three other sides required to complete the quadrangular inner court.

The upper terminal of this system of conductors commences in the metallic statue of the saint, which is fixed upon a strong central pivot of iron imbedded in the masonry beneath, and which serves the purpose of a weathercock. The point of the sword of the saint, which is no longer needed for the strife with the prostrate enemy of man, is raised to heaven, and acts as the first recipient of the lightning from an approaching cloud. But the sword is not left alone in the performance of this office. The platform on which the saint stands is the summit of a kind of cupola, covered with copper and lead, and around this is placed a group of eight vertical iron rods, which radiate above into a perfect forest of tufted points, or aigrettes. Each rod is itself tufted, and from a short distance below sends out a divergent spike; so that the metallic platform, beneath the feet of the statue, is guarded with a coronet of 48 points, distributed in a circle 16 feet in diameter, and bristling around in all directions.

The eight iron rods which terminate in this coronet of points, and in the metallic statue above, are each 10 millimetres, or about two-fifths of an inch in diameter, and together make up a section of 628 square millimetres, or a trifle more than one square inch. Each of these rods has a continuous and unbroken length of 100 metres, or 310 feet; and the eight rods under all the circumstances of the construction, collectively furnish nearly half as much facility again for electrical conduction as the limit of safety named in the standard instructions of the Academy of Sciences at Paris.

The eight main conductors descend along the octagonal faces of the tower, and then along the slope of the roof and the wall of the building, into the interior of the court-yard. As they do this, however, they gather up other strands of similar

* See page 536. Vol. 23 of the *Journal*.

† "Des Paratonnerres; description détaillé des Paratonneres etablis sur l'Hotel de Ville de Bruxelles; Exposé des Motifs des dispositions adoptées par Melsens, Membre de l'Académie Royale des Sciences de Belgique."—F. Hayez, Bruxelles, 1877.

character and size which come to them from the ridges and parapets of the quadrangular extension of the building, and from the subordinate turrets and gables. Tufts of points, or aigrettes, project upwards from these horizontal stretches of the conductor, as well as from the summits of the lower tower, in great abundance. Altogether there are thus 426 points, distributed in 60 aigrettes, and lying in 10 different planes, provided as air-terminals for the protection of this building. Of these 385 are of copper; 63 are of galvanised iron, and 8 are spikes gilded at the end. From one of the higher galleries of the tower the eye looks down upon a perfect *chevaux de frise* of spikes bristling up from the building into the air, in all directions.

But the earth-contacts of this remarkable system of protection are, perhaps, even more elaborately perfect in their details than the higher arrangements which have been thus far described. The eight iron rods come down from the tower along the inner wall of the quadrangular court-yard, and, at a distance of 3 ft. from the ground, they are carried into a square box of galvanised iron, and in it are metallically connected into one mass by zinc, which has been poured into the box in a melted state. In the sketch, at Fig. 3, this

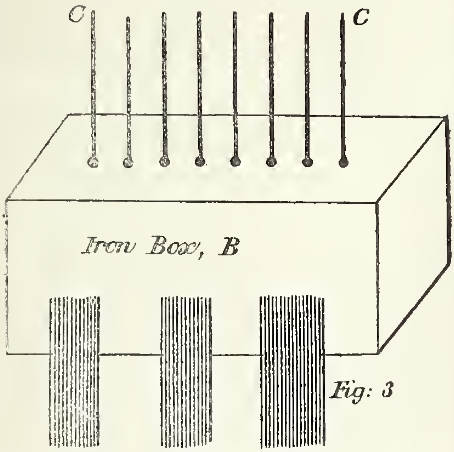


Fig: 3

box is represented by B, and the eight main stems of the conductor, C C, are seen entering its top. From the front of the box there are yet again three distinct bundles of iron rods, 1, 2, and 3, brought out from the interior of the case. Of these each bundle has the same conducting capacity as the eight rods taken collectively which descend from above. They are all, also, formed into one mass in the zinc contained within, so that they constitute, with the eight rods above, one unbroken conducting system, which amplifies itself three-fold in descending from the box towards the earth. Of the issuing bundles, No. 1 is carried by means of an iron tube, beneath the pavement, as shown at Fig. 4, and the several rods, C C, are then distributed round the top of an iron cylinder F, in a space lying between it and the collar. E E of a larger iron tube. This space, *a a*, is filled in with melted zinc, so as to make the substance of the iron tube and that of the iron rods metallically continuous. The tube, T, is a cylinder of cast-iron, 24 in. in diameter and 8 ft. long, and is sunk in a well hollowed out in the ground, and furnishing, at all times, a contact between the water and the

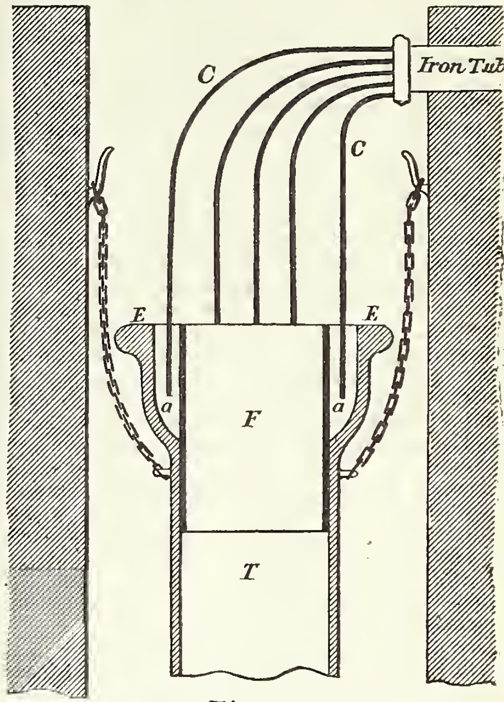


Fig: 4

iron of the cylinder of 11 square yards. The bundle of rods No. 2, which descends from the iron box, is carried to the iron main of the gas service of the town, and firmly attached to it; and the bundle No. 3 is attached, in a similar way, to the water main of the town. There is thus a three-fold earth connection for the system of conductors, for which Professor Melsens appears to have derived his suggestion from Faraday's description of the earth connections he had established for the galvanic battery of the Royal Institution, through the gas mains and water mains of the building.* M. Melsens estimates the entire contact between the earth and the underground surfaces of iron, which he expressively terms the contact with "le nuage souterrain," or subterranean cloud, as amounting to something like 330,000 square yards.

It will be observed that in its general character this system of conductors in a measure resembles the distribution of the fibres of a tree. The compact and compressed midway trunk, or stem, expands above into a myriad of branches and twigs, looking out into the air; and below into a still more abundant distribution of subterranean rootlets. That, indeed, is the idea of M. Melsens's "network" plan of defence. The building is covered above everywhere with bristling points, which render it virtually impracticable for the electrical charge to acquire a striking intensity in

* Philos. Trans., 1833. Page 31.

its neighbourhood; and the subterranean terminations of the rods, which are drawn together from the points, are so widely scattered into the ground, that whatever electrical currents do reach the rods from above are dissipated into the ground even more freely than they are received.

In alluding to the plan which is now so commonly advocated, of enlisting the mains of gas service in towns to do duty as earth connections for lightning-rods, it may now be necessary to say, in the way of caution, that no iron gas-pipe smaller than an inch should ever be allowed to approach to any part of a system of lightning defence, and that no gas-pipe of soft metal of any kind should be permitted to be near to the conductor. It must be well kept in mind that the very circumstance which makes the gas main so good an earth-contact for a conductor, constitutes at the same time a grave danger if this precaution is not observed. The mains of the gas service are generally so ample and excellent in the earth connections which they supply, that lightning striking a conductor with an ordinary earth-plate, or probably with some earth connection even less carefully provided than that, would be almost certain to leap across to any soft metal gas-pipe placed near to the conductor, in order to avail itself of that better and easier path to the earth; and, in doing so, would melt the soft metal, and set light to the gas. Fires are very frequently caused in this way. It is a radical axiom of lightning protection that the conductor must never be carried near to small, and especially to soft metal, gas-pipes.

One of the most interesting features of the work which Professor Melsens has been carrying on in connection with his labours at Brussels, is that various points of theory have been subjected to experimental investigation as the construction has been in progress. The Professor was kind enough to show me some of his experiments when I was in Brussels. I may advantageously speak of two of these. He has devised an arrangement of apparatus to show that it certainly is not true that an electrical discharge goes by the nearest and easiest path to the earth. He has distributed a series of conductors, somewhat in the form of a gridiron, in which a large central stem goes from a battery direct to the earth by the nearest possible path, and in which lateral branches of much smaller diameter make longer paths on each side of the central stem. When an intensity current, or rather a stream of intensity-discharges from an induction coil, is transmitted to the ground through this system of conduction, the knuckle advanced to the small outside and round-about threads receives a sharp shock, as well as when it is presented to the central stem. The fact is simply that the discharge traverses all the paths that are open to it, and distributes itself amongst them in proportion to the resistance which each different route affords.

Another very beautiful experiment is arranged, to show that although copper is a better conductor of electricity than iron, it has less molecular strength to resist the disentegrating influence of a powerful discharge. A fine wire is carried along for several feet, of which one-half is made of copper, and one-half of iron. The two halves are of exactly the same diameter and length. These wires are so placed as to be continuous with each other, so that the same discharge may have to pass through both. The discharge of a Leyden battery of fifteen large jars is then passed through these wires, and it is found that the copper wire is dissipated into black powder, but that the iron wire is only beaded along its entire extent, and not broken in its continuity. This affords some incidental support to the selection of iron, instead of copper, for the conductor at the Hotel de Ville, at Brussels. But the chief reason for this preference has really been the large cost of copper in a work of this dimension, where the conductors have to be so profusely spread in all parts of the building without any concomitant advantage from its employment, since an equally good result can be ensured by iron. The copper, it was conceived, would also have furnished a greater temptation to thieves in any exposed part of the structure to which light fingers could have found access.

In his "Description Détaillée des Paratonnerres," Professor Melsens insists very strongly upon a principle which I have already urged with some persistence from this place; namely, that "the chances of a lateral discharge from a lightning-rod decrease in proportion to the capacity of the conductor." I allude once again to this, because it is the fundamental condition upon which the efficiency of a lightning-rod depends. The importance of the large earth-contact, and the abundant supply of points, is but a part of the more general question of capacity as a whole. The tension of an electrical discharge has to be kept as low as possible as it passes through the rod, and that is accomplished in three ways:—1. By easy inlets through points. 2. By large sectional area of the rod; and 3. By spacious and free outlets to the earth.

There is one other passage in this book to which I desire also to draw something more than a mere passing attention,* because I glean from it that Professor Melsens holds that a "good earth" for purposes of telegraphy does not necessarily imply a "good earth" for the safe discharge of the lightning-rod, and that the indications of low resistance to a galvanic current do not certainly prove the efficient condition of a paratonnerre. He obviously conceives that the view which is ordinarily accepted upon this point should not in all cases be admitted without some qualification and reserve, and without precautions in carrying out processes of testing.

The method employed by practical electricians in testing the capacity of conductors for electrical currents and discharges is a very ingenious one, which depends for its efficiency upon the fact already alluded to in connection with one of Professor Melsens's experiments, that electrical currents diffuse themselves through conductors in proportion to the resistance offered in different directions. The instrument employed in the operation is some form of what is termed the "differential galvanometer." A copper wire is so arranged as to branch out into two circles, which run round a suspended magnetic needle, the one in a direction from left to right, and the other the opposite way. When a galvanic current is passed through this wire to the earth, as the two circles are of equal

* Page 70.

size and made of the same kind of wire, the current divides itself equally between them, and as one half of the current consequently goes round the needle one way, and the other half the opposite way, the needle is not deflected by either of them. It remains evenly suspended between the antagonistic impulses. If, however, a gap is made in one of the circles, and a source of increased resistance is introduced into that gap, a larger proportion of the current is immediately thrown into the other circle, and the needle does consequently deviate from its central position of rest to an extent dependent upon the excess of current that is influencing it. Known quantities of resistance, in the form of coils, can then be introduced into the other circle until the needle is brought back to its original position, and in that way these become the measures of the resistance which is required to be known. When a lightning-rod is introduced into one of the circuits of such a galvanometer, the needle will not deviate from the central line by more than one or two degrees, if the capacity and connections of the conductor are good. If, on the other hand, the conductor be faulty, the needle will diverge to a considerable degree.

From the reference which has been made to Professor Melsens' great work at Brussels, it will have been gleaned that there are two different systems of protection against lightning recognised by scientific electricians at the present day. 1. The system of multiple rods of weak sectional area,* which has been so skilfully carried into effect by its distinguished advocate at Brussels; and 2. The system of a single rod of large area so placed as to protect a considerable space around by its dominant height and ample dimensions.

Experience has virtually shown that either of these systems may be followed with equally satisfactory results, if intelligently and skilfully administered. M. Melsens holds that the multiple-rod plan is best adapted to structures such as he has had to deal with. A widely extended adoption, and a very successful use indicates that the single-rod system is, in its turn, as well suited for its work with buildings of a more ordinary size and of a different character. But the most important practical lesson which comes out of the comparison of the two systems is, perhaps, the suggestion that the one most commonly used has some points which are capable of being materially strengthened by borrowing something from the alternative plan. This may, however, be most serviceably expressed in the form of a condensed aphorismal abstract of the fundamental conditions that, in the existing state of electrical science, may be most advantageously observed in the construction of lightning-rods.

1. The copper rope, or rod, employed as the main stem of a lightning conductor, should in no case have a diameter of less than four-tenths of an inch.

2. A rope, or rod, of four-tenths of an inch in diameter is not large enough for the protection of buildings that are more than 80 feet high. The resistance offered by a conductor of any given diameter increases with its length. Long conductors, therefore, require to be of larger size than short ones.

3. For every additional 80 ft. of height, or of extent, a second rope, or rod, of the same transverse dimensions must be added, or the sectional area of the single rod must be increased in a similar degree.

4. It is of no practical importance whether the conductor possess the form of a rope of twisted wire, or of a rod, provided it be of sufficient dimensions for the work which it has to perform.

5. If a cylinder, or pipe, is used instead of a rope, or rod, it must be considered as furnishing the same conducting capacity that it would have if slit up along one side and opened out into the form of a flat band.

6. Galvanised iron may be used as a conductor instead of copper, but it must have considerably larger size, because iron is of inferior conducting capacity to copper. Increased size can quite compensate for inferior transmitting capacity.

7. An iron rope, or rod, to be equally efficient, must be rather more than double the width of a copper rope, or rod. In exact figures the proportional diameters needed is as 6·7 to 2·5. The conducting capacity of iron is five and a-half times less than that of copper, or, in more exact figures, as 14 to 77.

8. A galvanised iron rope conductor should, in no circumstance, be less than eight-tenths of an inch in diameter.

9. When a strip, or tape, of copper is used in place of a rope, or rod, it should be in no case less than three-quarters of an inch broad, and one-eighth of an inch thick. Such a strip contains a sectional area of a tenth of a square inch.

10. Galvanised iron, when used in the form of a strip, should be four inches wide and an eighth of an inch thick. Such a strip would contain a trifle more than half a square inch of sectional area.

11. A lightning-rod must be absolutely unbroken, or of continuous length from end to end.

12. When metallic water-pipes, or other similar stretches of metal, forming part of the structure of an edifice, are made to do service as lightning conductors, all joints must be carefully made good by solder, and tested afterwards to ascertain the sufficiency of their conducting capacity. Without this precaution, the arrangement is liable to be a source of danger, instead of a means of safety.

13. It is quite unimportant how a lightning-rod is attached to a building. It does not need insulating fastenings; ordinary metal clamps of any kind may be quite safely employed, provided the rod be of good conducting capacity, and otherwise efficient.

14. The rod must be terminated above in metal points, well projected up into the air.

15. The terminal points may be made either of copper, or iron, but they must be tapered out very gradually, and be perfectly sharp. An alloy composed of 835 parts of silver, and 165 parts of copper, forms an excellent material for tipping the points, because it enables these to preserve, for a long time, their sharpness under the circumstance of exposure to moist air. The silver tips should be made about two inches long, and be firmly screwed into the termination of the conductor.

16. The air-terminal of the conductor should be branched out into several points. Multiple points —or aigrettes, as they are termed—of this kind, are now made in copper, of very good form, by all the best electrical engineers.

* Conducteurs nombreux, mais à faible section.

17. The larger the building that has to be protected, the more points, or clusters of points, should be used. In the case of buildings of any considerable extent the conductor itself must be branched out to all parts, and each branch must end in its own projecting tuft of points.

18. Terminal points should project into the air, at least eight feet beyond the building itself.

19. The general idea may be kept in mind that lightning conductors approximately protect a conical space around them, whose base is four times as wide as the conductor is high. This principle, however, is not an infallible one, and it must not, therefore, be too implicitly relied upon. Whenever any parts of a building approach towards the limiting surface of such a conical space, additional points should be fixed there, and be brought into connection with the general system of the conductor.

20. The bottom of the conductor must be carried down into the earth, and be connected with it by a surface-contact of large extent.

21. About the best earth-terminal that can be contrived, consists in connecting the end of the conductor with the iron main of a gas-service, or water-service. The end of the conductor should be attached to a broad piece of copper or iron, and this should be laid close along the metal surface of the main underground, or, where practicable, be even attached to it by some kind of solder.

22. Where there is not the opportunity for adopting this expedient, the lower end of the conductor should be placed in a shallow trench, opened out 20 feet in the moist ground, and be carried along in it to the end, and be also well packed round with gas coke, broken into small pieces, before the trench is covered up with earth.

23. Plates of copper, or iron, may be used as earth-terminals, if this be preferred. The plate should not then, however, in any case, furnish less than two square yards of earth-contact, reckoning both sides, and it must be carefully rivetted and soldered to the conductor, and be surrounded with broken coke, before it is buried up in the earth.

24. When the earth is unavoidably dry, the earth-contacts of the conductor must be made proportionally large. Abundant size may be so managed as to compensate for the disadvantage of dryness.

25. With dry earth-contacts, lightning-rods may be a source of danger instead of safety, if this precaution be not observed. The only means by which it can be ascertained whether a dry earth-contact has been made large enough is the employment of the galvanometer. This test should never be omitted when the conductor terminates in a dry soil.

26. The danger of a lateral discharge from a lightning conductor diminishes with its capacity. A large well-pointed and well-grounded conductor will convey a very powerful discharge to the earth without the slightest tendency to strike through any object external to the rod. A small and imperfectly appointed conductor, on the other hand, is always prone, during the transmission of lightning, to flash off some portion to surrounding objects.

27. The capacity of a conductor may practically be increased in three ways to ensure this efficiency and safety:—1. By the employment of larger ropes or rods; 2. By a more abundant service of points; and 3. By amplification and improvement of the earth-contact.

28. The proof that a conductor has been made capacious enough by the judicious employment of these means, is furnished by the magnetic needle of a galvanometer not being materially deflected when a galvanic current is passed through the conductor to the earth.

29. All large masses of metal contained in a building should be metallically connected with the lightning-rod, unless when such are liable to be occupied by living people during a thunderstorm, as in the case of an iron balcony fixed outside a wall in front of a casement; it is then better that such masses should not be connected with the conductor, because, under such circumstances, persons standing upon them would be in less danger of being struck. When they are connected with the conductor there is always some risk of persons standing upon them furnishing a path for the lightning to the conductor.

30. The best method of connecting masses of metal with a conductor is by closed circuits. That is a connecting metallic band should proceed to them from two different parts of the conductor.

31. Soft metal gas-pipes must never be allowed to run anywhere near to a lightning conductor, because there is always danger when they are so placed of some part of the discharge deviating from its proper route to avail itself of the good earth-contact furnished by the expanded mains of the gas supply, and in doing so of melting the small fusible gas-pipe and setting fire to the gas.

32. Zinc or iron pipes on the tops of chimneys are always to be regarded as masses of metal that are to be brought into connection with the conductor.

33. Lofty chimney shafts may always be satisfactorily protected by a single conductor. Care must, however, be taken that the size of the conductor is adequate for the height, and the top of the shaft must be entirely encompassed by a bar or parapet edge of metal, and points must radiate from it on all sides into the air.

34. In the case of manufactories where corrosive vapours are emitted from the chimneys, copper or iron terminals should be soldered into leaden tubes, and a subordinate service of points should be added at some lower level, where they would not be liable to be affected by the corrosive vapours.

DISCUSSION.

Mr, Hale said the paper was rather too scientific for him, and he should like to have had some information as to how persons in open spaces could be protected against lightning.

The Chairman referred to an instance of a yacht being struck by lightning in Plymouth Harbour. The crew were down below, and he was assured by the master that the lightning was seen to pass through one of the Snow Harris lightning conductors, through the forecastle, without doing the slightest damage, and so satisfied was he of the efficacy of those conductors, that he said he would not mind sleeping with one close to his head. There were two other instances of the effects of lightning which had come under his knowledge, and which he should like to have explained. One was of a huge oak tree, about six feet in diameter, which was struck by lightning in Blenheim-

park some years ago. A dark cloud passed over, a single clap of thunder was heard, and the lightning passed, he presumed, more in the form of a bolt than the ordinary flash, but the effect was most remarkable. It struck the tree, and if it had been filled with gun-cotton it could not have done more damage. The whole tree fell to pieces. The lightning did not pass by a zig-zag course down the bark, the whole tree was torn to pieces, and thrown in every direction, as if an explosion had taken place from the centre. On another occasion, when he was on board ship, crossing the North Sea in summer time, the weather being very calm, except from a heavy thunder storm at night, the vessel was evidently enveloped in lightning. The mate told him the next morning that he could see the lightning flying about in every direction, and that he felt occasionally a sense of numbness. He believed the theory was an iron ship's huge masses of iron were not so likely to be struck by lightning as small masses—that the effect would be that the huge masses of metal absorbed the lightning, and it was a matter which perhaps Dr. Mann would be able to explain. The instance of the two wires, the iron and the copper, was very curious; and it occurred to him that the cause of the effect on the copper might be from the copper having a greater conducting power, and absorbing into itself a larger amount of electricity, than it could convey away, while the other portion which went into the iron had not the same effect. He took it that the lightning, wherever it might strike the building, or conductor, would invariably take the line of least resistance like any other form of electricity. He did not believe in the theory of its taking the shortest distance, but the line of least resistance. It would sooner pass through a longer distance of good conductibility than a shorter one of bad.

Dr. Mann said it was nearly so. It really passed through both in proportion to the resistance, but practically so little went through the great resistance and so much through the small, that it came out practically as the Chairman had stated.

The Chairman said wherever there might be a channel to the earth, it would pass through according to the relative distance. That theory was well established now, and was very valuable as the basis for calculation. The fact of chains having been broken showed that such things ought to be avoided as conductors, and some form of wire rope would be found infinitely better.

Dr. Mann remarked that the earth-contact at the Barrackpore accident was made by chains, and was one of the reasons of the great resistance.

The Chairman thought they might gather from what had been said, that lightning conductors ought to have an increased amount of conductibility the nearer they approach the earth, beginning at a point, and increasing until it got to the ground. The more the theory could be recognised, whether in the form of a rope, or like Snow Harris's plan of flat pieces of copper plate, the better. It ought to be, if possible, larger at the bottom than at the top, because the greater the distance over which the lightning had to pass through the conductor, the greater the probability of it passing to the ground with safety. He begged to move a hearty vote of thanks to Dr. Mann, for his instructive and interesting paper.

Mr. William Botly could corroborate from his own experience what seemed to be indicated in the paper, that the position of buildings had a great deal to do with their liability to be struck by lightning. Some years ago his late wife was staying at a farmhouse in Wiltshire, in an elevated situation surrounded by hills, when a thunderbolt, as it was called, descended, set fire to the thatch, and the whole building was consumed. He should like to know how it was that in some parts of the world there was a complete absence of thunder and lightning. A neighbour of his, who had been all round the world, told him that at St. Helena there never was a thunderstorm. Some people thought it was because it was 1,200 or 1,300 miles from the African coast. The lessee of the Long House, in which the first Napoleon resided, corroborated the statement, though he said he believed he had once heard the sound of thunder 70 or 80 miles from St. Helena, but he was not quite certain.

Mr. Liggins said he was old enough to remember the introduction of the tape, placed at the back of ships' masts, by Sir Wm. Snow Harris; that method had been generally superseded of late years, one reason being that sailors found that a convenient and safe plan was to hoist a rope with a point upon it to the mast-head by the signal halyards, and this was brought down the backstays of the ship, and then a long end was thrown overboard into the water. This was a very simple form; it was always ready, and could be hoisted in a few moments when a storm came on. The advantage of it was that there was no break of continuity as might sometimes happen with the other plan at the junctions of the different masts, if great care were not used in the joinings, and instances had been known where accidents had happened. With regard to the case of the yacht, probably the flash which was seen to pass through the forecastle arose from a break in the continuity of the band. It was not at all an unusual thing in yachts to alter the position of the mast; sometimes it was thought that altering it a few feet more forward, or aft, would make the vessel sail better, and, if that were the case, the copper band which went from the foot of the mast, through the keelson, to join the outside sheathing, might not have been properly connected. There was another reason why he believed ships were much safer now than they were years ago. He recollected when the first iron steamer was put on the Thames, the *Rainbow*, which he believed was still running; amongst the guests of the day was the Astronomer Royal, who in commenting on the fear which had been expressed that iron vessels would be exposed to danger from lightning, said the fact would be just the reverse, for there was such a large surface of good conducting material that the electricity would be dispersed over the whole surface, and would not be likely to make a spark in any part or portion. He believed that opinion had been verified, for he had never heard of an iron ship with iron rigging being struck by lightning, and he had crossed the Atlantic many times in the largest iron ships afloat, and had been in some of the most terrific tropical storms in the Gulf of Florida, and other parts. It was true he had never seen a wooden ship struck, but he had seen this:—Part of the rigging, the topsail tie, was always made of chain, and he had seen this chain one beautiful stream of light such as was observed when an electric spark was sent through a suitable material. It went down the chain and passed silently through the rope and off into the sea. If there were a break in the rigging of a wooden ship, particularly with hemp rigging, a serious discharge must occur, in consequence of the contact not being perfect. The result was that as far as practicable experience went he did not think there was anything safer than a wire-rigged ship with an iron hull.

Captain Townshend, R.N., thought Snow Harris's conductor preferable to the plan just mentioned of hoisting a rope. In theory it might be all very well, but at sea, on a storm coming on, it would be a very difficult thing to do.

Mr. Liggins said it did not take a minute, in the strongest gale that ever blew.

Captain Townshend said he spoke from practical experience, and he thought it would be objectionable; it was not merely the time, but if a storm came on at night, it would add to the difficulties to be overcome if you had to trice this up to the masthead.

On the other hand, Snow Harris's conductor was there always, and in practice it was always joined continuously. His experience in the navy was that this method was more useful. He had seen several contrivances for hoisting up something as an additional protection in very heavy storms, but in ordinary cases Snow Harris's was regarded as the best and most efficient conductor. He remembered an experiment conducted by Captain Snow Harris himself some time ago, to show the efficiency of conductors. There was a yacht, on board which the electric fluid was generated, and a little way off was a barge, on which was a barrel of gunpowder. A wire was taken from the yacht, through the barrel of gunpowder, then into the water again, and off to a launch which had a loaded 12-pounder on board. The end of the conductor was carried up to one side of the vent, and about an inch on the other side was another conductor. The result was that the electric fluid was carried safely through the barrel of gunpowder, fired off the gun, and then went on through the conductor on the other side into the water.

The resolution having been passed,

Dr. Mann, in reply, said the cause of the light seen in the yacht was unquestionably a spark from some break in the continuity of the conductor; but whenever a spark from lightning occurred it was so intense that it gave the impression that the whole place was filled with light. Hoisting a rope would be quite as safe as Snow Harris's conductor, and the latter would be equally good if it were perfectly continuous. There was the difficulty of always having the rope at hand ready for use, but it might be kept permanently in position if necessary. The cause of destruction in the case of the tree alluded to by the Chairman was perfectly well understood. It was simply the conversion of the moisture of the tree into steam at high pressure. The moment the electricity passed through, the moisture was converted into steam, and organic matters also were converted into gases, which being under high pressure the tree burst asunder in all directions. The case of the iron ship was a very interesting one. It was well known that a mass of iron, wherever there was electrical tension, either in the clouds or passing as a flash through the air, was in a state of induction. There was a tension raised in it, and very often, even when there was no shock, this was sufficient to make one's hair stand on end, and produce other effects of electricity. The Chairman's explanation with regard to the copper and iron wire needed a slight modification. The copper did not absorb electric force, but it conveyed it readily, and good conduction meant that it slipped away easily. The reason of the effect observed, no doubt, was that the iron had more molecular resistance than the copper, and, therefore, although the copper conducted more readily, the iron offered more resistance, and the iron atoms were not so readily pulled asunder. The suggestion of increasing the size downwards was well known, but you must increase both ways, upwards and downwards, so as to get the arrangement of a tree. The trunk of the tree would represent the middle of the conductor; and it should have its leaves and twigs spread widely above, and its rootlets below in the earth. There were regions and seasons in which storms occurred very frequently; he knew one district in Natal which was absolutely a desert, the natives would not go there, because of the constant thunder storms. There were various causes for this; one was the presence of ironstone in the earth, and the existence of mountains was another.

Mr. Liggins remarked that at Cape Hatterat there was said to be a thunder storm every night.

Dr. Mann said when he was in Natal he expected three every week during half the year. The comparative immunity of some places from thunder storms, and their great frequency in others, was somewhat a large subject to speak of at the conclusion of a discussion which had been already prolonged to a somewhat late hour. But thus much might, perhaps, be said in explanation. Some situations supply the physical conditions upon which the rapid development of free electrical force depends, and others do not. Thunder storms, above all things, require a sudden and rapid rise upwards of air heavily laden with moisture, and the copious and sudden deposit of that moisture in the form of rain. It was the sudden change from the vaporous to the liquid state of the aqueous constituent of the atmosphere which set free the large supply of electric force. It was for this reason that thunder storms were so prevalent in mountainous regions, and especially where moist lee winds are driven in upon and up their slopes, as happens along the south-eastern coast of Africa where the mountainous edge of the table land of the continent, some 5,000 or 6,000 feet high, ranges within 100 miles of the sea, and receives the moist south-east winds from the Indian Ocean; and that they were so comparatively rare in the open regions of the broad ocean, where the currents of the winds drift horizontally along. As a general rule, rainless regions of the earth were necessarily without thunder storms. St. Helena was a comparatively rainless region, lying within the steady horizontal drift of the trade wind, and consequently thunder storms were there comparatively rare. During the dry winter season in Natal thunder storms are very seldom seen. In the wet summer season they are very frequent and abundant. This was simply because in the one season the physical conditions upon which the development of the thunder storm hangs are absent, and in the other season they were present in great force. It was the same thing with territorial situation. Where the essential conditions did not prevail at any part of the year, any more than they did in Natal in the dry part of the year, there were no thunder storms at all. In sailing along the 20th meridian of West longitude from the 30th parallel of North latitude, towards the equator, in the North Atlantic, he had night after night seen the sky illuminated with the lightning flashing over the African Continent towards the East, without encountering a single storm out on the sea. This very strikingly illustrated the influence of the land in developing the up-currents of air, and other essential conditions, on which the development of the storm depends. When in Natal his attention was much directed to the question of devising some protection for persons travelling about on the open country, and he attempted the construction of a kind of umbrella, with points of wire, in such a manner that anyone who was caught in a storm might sit down and cover himself with it, and putting a good earth-contact to it, there would be fair protection. But he always found that no one had the umbrella when it was wanted. The one thing to do in such a case was to lie down flat on the ground, never mind getting wet, the wetter you were the better, and you would be tolerably safe. He was quite sensible of the imperfections of his paper, but he had endeavoured to summarise the practical results in the aphorisms, which he had been obliged to omit in reading it.

The Chairman asked if Dr. Mann could explain the cause of the particular form of electricity which was sometimes seen in the shape of a ball of light resting on the yard-arm of a ship?

Dr. Mann said there were two forms in which ball lightning was seen. One was simply the glow which a mass of air, or cloud, in a state of high discharge would show, and would appear to rest on the point of the conductor which was receiving it; it was the same thing as the light which was seen on the spears of Cæsar's soldiers. The other form of ball lighting was always distinguished by its slow motion. Lightning passed with a rapidity of 200,000 miles a second; but this globe lightning, if seen in the room, would appear to walk slowly

through it. Many attempts had been made to explain this, but the only explanation at all satisfactory was that it was also a form of the glow. The notion was that, when a mass of vapour in high tension was moving through the air, it presented a point like a spear point, and that, as it moved along, the rate was so slow that it could be followed, and the glow discharge issuing from it made a mass of light. The tension, however, was so great that it might burst at any moment into a flash.

[A very convenient and excellent form of galvanometer for testing the efficiency of lightning rods, contrived by Mr. Anderson, the manager of Messrs. R. S. Newall and Co., of Wellington-street, Strand, and of Gateshead-upon-Tyne, was placed upon the table. In this galvanometer three galvanic cells of the carbon and oxide of manganese constant battery, are employed to produce the current, and the indicating magnetic needle of the galvanometer, round which the current is transmitted, is exposed for observation at the top of the lid. Three keys, also situated on the lid, can be pressed down in succession to bring more and more resistance into the current, for measuring the resistance of the conductor by comparison. There is also an arrangement for conveniently placing the conductor and its earth-contact in circuit when the comparison has to be made. This instrument is very simple and admirable in its construction, and well deserving of notice and commendation. Messrs. Newall also very kindly sent for exhibition the beautiful series of conductors of various capacities, and of copper and iron, which were placed upon the table.—R. J. M.]

CORRESPONDENCE.

INDIAN IRRIGATION.

Had time permitted on February 26th, I had wished to draw the attention of the meeting to the circumstance that, although the cost of the main irrigation canals was so large as to require State expenditure, the cost of distributing water from those canals might be within the means of individuals, or small associations of individuals.

In this country, not only have the loans which the Government had power to advance to individuals for land improvement purposes (which, in practice, is limited to £5,000 in each case) been taken up, but very large sums have also been profitably advanced and turned over for similar purposes by private companies. It might, therefore, be hoped that small beginnings in India might lead to equally satisfactory large results.

I had also wished to suggest that part of what the Government has now undertaken to do when a famine occurs, is to distribute food either gratuitously or in exchange for labour on relief works. Where adequate means of communication exist within a limited distance of those communications, prevention of famine in India is now reduced to a question of forethought and expenditure of money, although the sums required may be very large.

But it is necessary that provision should be made for the prevention of famine in those districts, which are inadequately supplied with the means of communication, or in which irrigation from a permanent supply of water is deemed impracticable, for there it would be a question not of money, but of lives. The Government keeps its magazines filled with war material either manufactured in its own arsenals or purchased in the best markets, and, judging from past experience, the purchase and storage of grain by Government, in some exceptional districts during seasons of plenty, might be of the greatest practical value for the prevention of famine in those districts in times of drought.

Sir Arthur Cotton, in his "Rejected letter to the *Times* in answer to Sir James Stephen," states the cost of river water delivered by Government on to the land to be one rupee per 1,500 cubic yards. It is worth consideration whether there be not many localities in which such an amount of water at the same cost could not be supplied by steam-pumping and private enterprise.

J. T. Wood.

March 1st, 1878.

The question discussed at our meetings on the 22nd and 26th February is so important, and it is so desirable that any erroneous statements made should be put right, that I shall be glad if you will allow me by this letter to supplement what I said briefly. I am referring more especially to what was said by Mr. Elliot, who followed me almost immediately, and to whom I could not, of course, reply then; while I do not see that the chairman or Mr. Thornton alluded to what, I venture to think, is a very incorrect statement indeed. When Mr. Elliot spoke of the debt and revenue of India, he stated the "public debt of India, including the guarantees on the railways as 230 millions, and the income from taxation as only 38 millions" (I quote from your report), and he went on to say that that "was the only income that could be relied on, as the sum derived from opium and so on might be cut off at any moment;" and he stated "that it was thus shown that the liabilities of India were six times that of England, and yet there were persons who advocated the increase of that liability by borrowing enormous sums of money for irrigation purposes." As I had ten minutes before been advocating Government borrowing for well-considered works of irrigation, I fear I must bear my part in this sweeping censure. When Mr. Elliot spoke of the Indian debt as 230 millions, including the railways, a gentleman exclaimed, "Why, you should credit, then, the revenue from the railways." That is just it. I have before me the Parliamentary return of the Indian debt to 30th September, 1877, and it was that day, in millions sterling, 73 in India and 55 in England—say 130 in all—and to this Mr. Elliot adds 100 millions for railways, but appears quietly to leave out the revenue from them, though it is notorious that last year they more than paid the guaranteed interest. I understand Mr. Elliot is a coffee planter; so am I, in one sense, as being a director of two coffee companies, but assuredly, if I bought a coffee estate for £10,000 on credit, while I added this sum to my "indebtedness," I should credit in my "revenue account" the net profits from the estate. I have also by me the "East Indian Finance and Revenue Accounts for 1875-1876, with Estimates for 1876-1877," and they show (page 177) that the total revenue for 1875-6 was $52\frac{1}{2}$ millions sterling (fractionally £52,515,787), with an estimate for 1876-7 of £51,220,713. Of course, the railways are not included in either debt or revenue. I do not know if Mr. Elliot actually used the words "opium, and so on," and I cannot, therefore, make out how he manages to reduce the revenue from $52\frac{1}{2}$ to 38 millions. I find what I said myself is not quite accurately reported. I did not say that "it had been stated over and over again that railways in India were not a success," but that "for some time after they were made, their success was an uncertainty, that some people said they would be a failure, but that now 98 men out of 100 fully admitted it, and that I thought this favourable result might reasonably encourage the Government of India to extend another class of public works"—works of irrigation. Mr. Thornton spoke of "50 millions being spent in the briefest possible space," and Sir Arthur Cotton had complained of part of the "Godavery" works having occupied 20 years in making—instead of three. I entirely agree in their views that any works the Government can see their way to making should be finished and

begin to earn revenue as soon as possible. Of public works generally, and also all in India, it may be said emphatically "they who build quickly build twice." While it is quite true, as pointed out by Mr. Thornton and Mr. Cassels, that "irrigation loans" in England would increase the amounts to be remitted annually by India to England, and while I would gladly see India herself provide for all India wants, I feel all too certain that India will not, as a country, do so. Look at the railways, where, even now, the stock held by natives of India is a mere trifle. Doubtless, every new loan, the interest on which is payable here, increases the amount of the Council's drafts on India; but successful productive public works, like the railways, not only pay the interest, but so increase the general wealth of the country and the volume of its exports, that what is called the "Indian tribute" can more easily be borne. No one knows better than Mr. Cassels, himself a merchant, and now a member of the India Council, how the Indian export trade is increasing—above all, in wheat, oil seeds, &c.—and how much this is attributable fairly to the wise and courageous action of the Government in connection with railways and the repeal of the export duties. We all know that, only a short time since, the Indian exchange was down to 1s. 6d. per rupee; a few months ago it was up to 1s. 10d., and is now 1s. 9d., nearly its normal condition of late years. How much of this, and how much of the benefit the Government derives from this great rise, is attributable to the increased produce and exports of India? WILLIAM MAITLAND.

Oriental Club, 6th March, 1878.

I attended the reading of Mr. Thornton's paper, read before the Society, with the hope that I might be able to aid in developing Mr. Thornton's useful contribution "On Irrigation regarded as a Preventive of Indian Famine." The time available for each speaker being unavoidably limited, I necessarily restricted my remarks, and I now hope I may be permitted to point out some facts of Mr. Thornton's paper misleading in their tone, and calculated to shake that thorough confidence in irrigation which I believe ought to exist, so far as the Madras Presidency is concerned, to which part of India my remarks refer.

The idea most likely to be formed from reading Mr. Thornton's paper is the insufficient supply of water for extended irrigation in the Madras Presidency. The remarks to this effect occur in several parts of the paper, and the Godavery, Kistnah, and Cauvery rivers are prominently pointed to as being dependent on fluctuating rainfalls and uncertain clouds. There is no proof given as to the uncertain rainfall, in fact, the proofs are strong in support of the idea that the quantity of rain is not less now than formerly; but the special mention made of the Godavery furnishes proof of the abundance of water in that great river, even in the terrible year of water drought. Mr. Thornton states that the water of the river passed over the dam across the Godavery, which is 4,000 yards wide, to the depth of two or three feet. This one fact, admitted by Sir Arthur Cotton, at once shows the vast stock of river water still allowed to run waste to the sea. The water was so abundant, that after filling all the channels now available for carrying water on to the fields, there is a sufficiency of water to irrigate one million of acres, so as to save the crop.

Now, in ordinary years, this surplus water is measured by the depths of 7 or 11 feet, passing over the dam, as Mr. Thornton states. But he might have used the depths of 16 feet and 17 feet, these being the depths in the two years prior to the two years from which he has taken the measurements. The quantity of water allowed to run waste in the famine year would have been multiplied many times, if Mr. Thornton had stated the number of days of high floods of the Godavery, and the recorded daily measurements. The official documents available in the India-office supply that information. The area that could have been irrigated with this wasted water, in one day of the famine year, is nearly four times the area of Bedfordshire, at 500 acres to the square mile. Now an irrigated acre of land yields sufficient grain to feed seven persons for the whole year. This ratio of feeding power may be assumed, from the admission made by Mr. Thornton, that irrigation "doubles," "trebles," "quadruples," "possibly even octuples crops of all kinds." Our Public Works Commission reported that irrigation quadruples the quantity and value of the produce, as compared with that obtainable from unirrigated land, besides diminishing the labour. The water, when available for irrigation, renders the crop a certainty. It is, therefore, not the want of water in this district which restricts irrigation.

The practical way of looking at the doubt excited about the insufficiency of water in the Godavery, in the last, or famine year, is to examine the yield in money from the land of that district. In the famine papers laid before Parliament the table of collections of land revenue for the year ending 30th June, 1877, shows the land revenue actually collected to have been upwards of £421,000, being the largest receipt in any one year, as far as I can discover, since the great irrigation works were commenced.

The next consideration is whether these works are yet carried out to the extent possible. Now, the excess of water above the present wants being proved to be abundant, it may be asked can it be stored up for use. I abstain from quoting Sir Arthur Cotton as an authority, although no one is more entitled to express his opinion, but I mention the name of Colonel Baird Smith, who, after his visit to the Godavery Works, now more than a quarter of a century ago, distinctly stated that additional water storage power would be needed ere long; that want has long been felt, and representations have been made to meet it. The site for storing up the present surplus water, often pointed out, is about 30 miles above the existing dam. There a magnificent reservoir could be formed, from which water could be spread over lands now desolated by droughts, and this reserve stock would aid not only in greatly extending the existing splendid irrigation of the Godavery delta, but would supply water for raising seed in anticipation of the river filling.

The land in the Godavery delta, held direct from Government, has since 1851-52 been largely irrigated. In that year the irrigated area may be stated at 131,000 acres, and even then supplied with water mainly from the new works. At present the irrigated area is upwards of 300,000 acres, and in addition, the lands of other areas held by parties or tenures different from the tenure of the Government land, are also supplied with water from the Government works. The revenue derived from that irrigated area may be stated at £180,000, against £50,000 in the former period. The measure of value may be judged by the fact that the unirrigated land held direct from Government is in area about 442,000 acres, and yields a revenue of about £70,000.

The whole question of this increased irrigation rests then on three conditions, water, land, and money. The water is proved to be available in this district, and land is still abundant, and the money question may be settled by knowing that in the year ending 30th June, 1875, the actual receipts of revenue from all sources amounted to £545,000, against £250,000 in the year ending 30th June, 1854. The land revenue was then about £200,000, it is now upwards of £421,000. The revenue from various other sources was formerly about £45,000, against £125,000 in 1875.

I do not desire to claim credit for this remarkable increase in revenue, but it is not unreasonable to say that a large share of credit is due to the construction of works on the Godavery; the vast increase in the value of

the produce from irrigated lands must have added largely to the wealth of the district.

I must also point out that in Mr. Thornton's paper read before the Society in 1876, the rate of profit derived by Government from the increase of revenue depending on the works was stated at close on 40 per cent. on the capital expended. With such magnificent results, it is needless to question the insufficiency of this enormous profit. The Madras Government now possessing such an improved finance in one district alone, is it unreasonable to ask that the surplus revenue above the amount collected twenty years ago may now be invested in irrigation works, to prevent the often famine-stricken districts of Bellary, Cuddapah, and Kunval.

These three districts, Bellary, Cuddapah, and Kunval, are unavoidably united as a whole, owing to the alteration in areas within the last 25 years, so that, though the the total area is the same as formerly, the areas of the respective districts differ.

The financial results of the famine may be understood by the statement that the land revenue collected in these three districts, in the famine year ending 30th June, 1877, only amounted to £63,000, against a collection in the year previous of £603,000, and of £605,000 in the year before that.

There is no part of the Madras Presidency so backward as these three districts, judging by revenue. Since the year 1854, the total collected revenue of these three districts has swelled up from about £530,000 to £775,000, the land revenue has only increased from £420,000 to £605,000 in 1875. The other sources of revenue from £104,000 to £170,000. These differences are far less in the ratio of increases in other parts of the Presidency.

Comparing the areas, the Tanjore district is only one-seventh of the three districts; the population of that one-seventh being two-thirds of the greater area. The total revenue collected from that small area being £748,650 in the year ending 30th June, 1875, against the total collection as above of £775,000.

In these three districts, there have been in 45 years, many severe famines and numerous minor distresses. In Tanjore no famine has occurred during a long number of years, and since the great works over the Cauvery and Caleroon were undertaken by Sir Arthur Cotton, no year has passed in which the revenue of this prosperous district has suffered materially.

The condition of the two divisions are not peculiar as regards available land. In Tanjore there are 214 square miles of zemindary land on which there is a permanent assessment. In the three districts the zemindary land is only 317 square miles, a much smaller ratio to the total area than to Tanjore.

The water supply of Tanjore is not so abundant as in the three districts, neither is the soil of Tanjore in any respect superior, or often equal to that of the three districts, and the ratio of cultivable area is not less therein. The marked feature on the two divisions is the great difference between the areas irrigated. In Tanjore the total irrigated area is about 872 acres, in the three districts only 340,000. The ratio to the cultivated rrea of the three districts is about one-twentieth of irrigated. In Tanjore the area is nearly seventy per cent. of cultivation.

Then, in contrast with the progress of irrigation in the last 25 years, I cannot make out any augmentation in the three districts. This may be owing to the revision of the tenures in these three districts. The land was formerly enormously overtaxed, and large tracts thereby left uncultivated. The great modifications in rates, and a re-classification of lands formerly held as garden, or wet—when no water was supplied—may have so altered the returns of cultivation as to have shown an actual decrease in the irrigated area, and not an increase either in area or in revenue as the present returns show in contrast with the former period.

With these facts few can doubt that additional irrigation would have proved beneficial to these three districts. It may be claimed for this shortcoming that the population has not increased as in other parts of Madras. Sir R. Temple cynically remarks that, in the least irrigated districts, the ratio of population to area is least. This saying is fully borne out by the state of the population in the three districts; famines and scanty supplies of food most effectually depress the births and marriages and multiply the deaths.

The want of water cannot be pleaded in excuse for diminished irrigation, for the great river, the Toonjabhudia, borders the districts of Bellary and Kunval, and pours its waters in abundance, not only in ample quantities to water the delta of the Kistnah district, but to allow of vast quantities being poured into the sea.

I am aware of the doubts thrown by Mr. Thornton on the sufficiency of the water supply in the last year, but there are no proofs given of its insufficiency, and, judging by the collections of land revenue, I do not consider the doubt justified. I must also add that no sound has come from the Madras Irrigation Company as to insufficiency of water in the Toonjabhudia, which partly feeds the supply of water which is averted by the dam of the Kistnah works for the irrigation of Masselipatam and Gunton.

Further, in the year ending 30th June, 1875, the rainfall in the three districts was throughout the whole area uniformly abundant. Probably, in few previous years has the rain been so propitious, as to uniformity over the whole area, and in quantity nearly double the ordinary fall.

If suitable reservoirs had been available, there can be no hesitation in asserting the practicability of obtaining ample supplies of water to irrigate at least two millions of acres in the three districts. Even the defective and insufficient tanks were in that year unusually well filled, but along with that advantage was the serious one of many tanks being breached or injured. But both in Cuddapah and in Kunval the reports stated that much injury was done to the irrigation works of their districts.

As Mr. Thornton uses words to give currency to ideas inimical to irrigation, and as these words may be found in the various reports of Sir R. Temple, I may be allowed to quote the substance of a remarkable report made by Sir R. Temple, on the defects of the tanks in the sub-collectorate of the Cuddapah district.

This portion of the district is less than one half of the total area, but in it we find the remarkable number of 4000 tanks; the area is studded with these irrigation works. But Sir R. Temple states that "many of them have been breached in former years," "many require repair and improvement," "some are gradually silting up." The remarks of Sir R. Temple in regard to employing the decrepid labourers, all tended to the execution of work on irrigation works tanks. In this district Sir R. Templo strongly urged their employment on these works as being "the very life of the country, and which directly pay judicious expenditure by immediate increase in land revenue." He also urged that persistent efforts should be made, with the help of the engineering staff, to employ more labour gangs on tanks and irrigation works, and fewer on roads. G. H. BALFOUR.

GENERAL NOTE.

Carving in Wood.—Signor Bulletti, of Florence, has recently opened a school for giving practical instructions in the art of wood carving. Signor Bulletti was occupied for five years on the decorations of Alnwick Castle, where he formed a studio of carvers in wood, who executed the work under his instructions. Since leaving Alnwick he has been occupied in teaching pupils this art, now at such a low ebb in this country, and with the view of still further extending a knowledge of it, he has opened the school above referred to. For further information application should be made at the school, 6, Adam-street.

NOTICES.

THE LIBRARY.

The following work has been presented to the Library:—

A Short History of the Egyptian Obelisks, by W. R. Cooper, F.R.A.S., with Translations of the Hieroglyphic Inscriptions, chiefly by François Chabas. (London: Samuel Bagster and Sons, 1877.) Presented by the Author.

The following Pamphlets have been presented:—

What is Art Culture? An address delivered to the Manchester School of Art, 21st December, 1877, by Sir Henry Cole, K.C.B. (Manchester.) Presented by the Author.

Narrative of the Discovery of the Great Central Lakes of Africa, by J. L. Clifford Smith, F.R.G.S. (Halifax: 1877.) Presented by the Author.

History of the Manufacture of Nickel and Cobalt, by Stephen Barker. (Birmingham: 1865.) Presented by the Author.

The Manchester Steam Users' Association. Chief Engineer's Monthly Report for November and December, 1877. (Manchester.) Presented by the Association.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at eight o'clock.

March 20.—"Emery and Corundum Wheels for Grinding and Surfacing Metals and other Materials." By A. H. Bateman, Esq., F.C.S.

March 27.—"State Aid to Music at Home and Abroad." By Alan S. Cole, Esq.

African Section.

Tuesday evenings, at Eight o'clock.

March 19.—Egypt; its Commercial Changes and Aspects." By B. Francis Cobb, Esq.

Chemical Section.

Thursday evenings at eight o'clock.

March 28.—"Electric Lighting," by Dr. Paget Higgs.

Indian Section.

Friday evenings at eight o'clock.

March 15.—"The Colonisation of Hill Districts in India." By Lieut.-General McMurdo, C.B. Edwin Chadwick, Esq., C.B., will preside.

Cantor Lectures.

Monday Evenings, at Eight o'clock. Second Course, on "The Application of Photography to the Production of Printing Surfaces and Pictures in Pigment." By Thomas Bolas, Esq., F.C.S.

Lecture V.—March 18th.

Collotypic printing.

MEETINGS FOR THE ENSUING WEEK.

Mon.....**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Thomas Bolas, "The Application of Photography to the Production of Printing Surfaces and Pictures in Pigment" (Lecture V.)
Royal United Service Institution, Whitehall-yard, 8½ p.m.
British Architects, 9, Conduit-street, W., 8 p.m. Prof. Donaldson, "Obelisks; their Purpose, Position, Proportion, and Materials."
Medical, 11, Chandos-street, W., 8 30 p.m.
Asiatic, 22, Albemarle-street, W., 3 p.m.
Victoria Institute, 10, Adelphi-terrace, W.C., 8 p.m. Professor Swainson, "Was the name Jehovah known to all Shemitic Nations?"
London Institution, Finsbury-circus, E.C., 5 p.m. Mr. R. A Proctor, "The Youth of a Planet."

Tues....**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (African Section.) Mr. B. Francis Cobb, "Egypt; its Commercial Changes and Aspects."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Garrod, "The Protoplasmic Theory of Life and its Bearing on Physiology." (Lecture X.)
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Discussion upon Captain Douglas Galton's paper on "Railway Appliances at the Philadelphia Exhibition of 1876."
Statistical, Somerset-house-terrace, Strand, W.C., 7¾ p.m. Mr. C. Walford, "The Famines of the World."
Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.
Zoological, 11, Hanover-square, W, 8½ p.m. 1. The Marquis of Tweeddale, "Contributions to the Ornithology of the Philippines, No. VI. On the Collections made by Mr. A. H. Everett in the Island of Leyte." 2. Mr. P. L. Sclater, "Reports on the Collections of Birds made during the Voyage of H M S. *Challenger*, No. VIII. On the Birds of the Sandwich Islands."
Royal Colonial, Pall Mall Restaurant, 14, Regent-street, W., 8 p.m. Sir Julius Vogel, "New Zealand and the South Sea Islands, and their Relation to the Empire."
Royal Horticultural, South Kensington, S.W., 11 a.m.

Wed....**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr. A H. Bateman, "Emery and Corundum Wheels, for Grinding and Surfacing Metals and other Materials."
Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Discussion on Dr. Tripe's Paper, "The Winter Climate of some English Sea-side Health Resorts." 2 Captain W. Watson, "Notes on a Waterspout." 3. Mr. M. Fitzgerald, "Notes on the Occurrence of Globular Lightning and of Waterspouts in County Donegal, Ireland." 4. Mr. W. Black, "Observations of Rainfall at Sea."
Geological, Burlington House, W., 8 p.m. 1. Mr. W. A. E. Usher, "The Triassic Rocks of the South-western Counties. Part II. Chronology." 2. Mr. J. W. Hulke, "Note on the Os Articulare, presumably that of *Iguanodon mantelli*." 3. Mr. E. Tully Newton, "Description of a new Fish from the Lower Chalk of Dover." 4. Mr. R. Ethridge, jun., "Further Remarks on Adherent Carboniferous Productidæ."
Royal College of Physicians, Pall-mall East, S.W., 5 p.m. (Gulstonian Lectures). Dr. Ferrier, "The Localisation of Cerebral Disease." (Lecture II.)
Archæological Association, 32, Sackville-street, W., 8 p.m. 1. Mr. Henry Prigg, "The Exploration of Early Earthworks on West Stow-heath" 2. Mr. E. P. Loftus Brock, "The newly-discovered Cavern at Eltham."
Society of Public Analysts, Burlington-house, W., 8 p.m. 1. Mr A. Wynter Blyth, "The Amendment of the Sale of Food and Drugs Act" 2. Mr. A. H. Allen and Mr. R. Bodmer, "Experiments on the Determination of the Free Acids of Vinegar."

Thur....Royal, Burlington House, W, 8½ p.m.
Antiquaries, Burlington House, W., 8½ p.m.
Linnean, Burlington House, W., 8 p.m. 1. Mr. John Gorham, "The Venation of *Conium maculatum*." 2. Mr. B. Clarke, "A New Arrangement of the Classes of Zoology." 3. Rev. M J Berkeley and Mr. C. E. Broome, "The Fungi of Queensland (Australia)."
Chemical, Burlington House, W., 8 p.m. 1. Dr. Witt, "Nitrosamines." 2. Mr. J. B. Hannay, "A New Process for the Volumetric Estimation of Cyanides." 3. Mr M M. P. Muir, "Certain Bismuth Compounds." (Part VII.)
London Institution, Finsbury-circus, E.C., 7 p.m.
Society for the Encouragement of the Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. Daniel Grant, "The Greek Drama."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Chemistry of the Organic World." (Lecture IX)
Numismatic, 4, St. Martin's-place, W.C., 7 p.m.

Fri......Royal Institution, Albemarle-street, W., 8 p.m., Weekly Meeting. 9 p.m., Prof. Tyndall, "Recent Experiments in Fog Signals."
Quekett Microscopical Club, University College, W.C., 8 p.m.
Clinical, 53, Berners-street, W., 8½ p.m.
Royal College of Physicians, Pall-mall East, 5 p.m. (Gulstonian Lectures). Dr Ferrier, "The Localisation of Cerebral Disease." (Lecture III)

Sat......Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Rev. W. Houghton, "Natural History of the Ancients." (Lecture II.)

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,322. Vol. XXVI.

FRIDAY, MARCH 22, 1878.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

PRACTICAL EXAMINATIONS IN MUSIC.

The examinations will be exclusively practical, and will take account of voice, style, ear, and reading.

Candidates in vocal music will be required—

1. To sing a solo, or to take part with another candidate in a duet, already studied. Credit will be given or the choice of the piece sung.

2. The pitch of a key-note being given, to name sounds or succession of sounds, played or sung by the examiner in that key and in the keys connected with it; *e.g.*, the dominant, subdominant, relative minor, or other.

3. To sing or solfa at sight passages, selected generally from classical music.

Candidates in instrumental music will be required—

1. To play a piece already studied. Credit will be given for the choice of the piece played.

2. The pitch of a key-note being given, to name sounds, played by the examiner in succession or in combination, in that and its relative keys.

3. To play a piece or portion of a piece at sight.

The maximum of marks is 100. These will be distributed among the subjects of examination in the following proportion:—

VOCAL MUSIC.	
Voice	20 per cent.
Style	20 ,,
Ear	20 ,,
Reading	40 ,,
INSTRUMENTAL MUSIC.	
Execution	20 per cent.
Style	20 ,,
Ear	20 ,,
Reading	40 ,,

Candidates who obtain 75 marks will be entitled to a first-class certificate; and those who obtain 50 to a second. Candidates, the number of whose marks is below 30, will be entered as "not passed."

Before admission to the examination all candidates must have sent in a certificate, from a professor or other musical authority, to the effect that their qualifications are such as to afford a reasonable chance of their passing. Vocal candidates must come provided with a second copy of the solo or duet they have studied, in the established notation.

CANTOR LECTURES.

The fifth lecture of the second course, on "The Application of Photography to the Production of Printing Surfaces and Pictures in Pigment," by Mr. THOMAS BOLAS, F.C.S., was delivered on Monday evening last, the 18th inst. These lectures will be published in the *Journal* during the recess.

INDIAN SECTION.

Friday, March 15th; EDWIN CHADWICK, C.B., in the chair.

The paper read was—

SETTLEMENT AND MILITARY COLONISATION IN INDIA.

By Lieut.-General McMurdo, C.B.

The British have now been in India, as conquerors, for about 120 years. In 1757 the tide of victory set in under Clive at Plassy, and continued to flow in successive and ever-expanding waves of conquest under Wellesley, Lake, Combermere, Napier, Hardinge, and Gough, till the series of wars, resulting in annexations of territories, was closed by Clyde, in 1857, with the defeat of the mutineers, and the consolidation of Oude as a province of the British Indian Empire. Thus, in exactly one century of successive conquests, countries, the aggregate area of which amount to 900,000 square miles, with their populations exceeding 190 millions, were brought directly under British rule; while native States, tributary or otherwise, subsidiary to the Imperial crown, swell these figures to 1,500,000 square miles, and the populations to 240 millions.

It must be admitted that throughout this eventful period of one hundred years, little appears to have been accomplished by the dominant race to give the stamp of European civilisation to the countries that they conquered. It may be urged, with some truth, on behalf of the government of the East India Company, that, as a rule, the rapidity of conquest outstripped the march of civilisation. Still, after making every allowance for frequently recurring periods of political distraction and their consequent wars, the verdict of apathy and selfishness can scarcely be withheld.

Although I am not here for the purpose of preferring charges of mis-government against the East India Company, I still consider that I should not be in a position to address you to-night upon the important subject before us, if I did not first show that the little progress made by Europeans as settlers in India, during the period referred to, was due to obstructive legislation on

the part of the Court of Directors, and not from the often alleged impossibility of Europeans living in India and perpetuating their race. In doing this, I shall not make any assertion that is not capable of proof; and in this view I am fortunate in having had access, through the kindness of the Secretary of the Indian Section of this Society, to the report of the Select Committee of the House of Commons appointed, in 1859, to inquire into the question of colonisation and settlement in India, especially in its hill districts.

That report was the result of carefully sifted evidence; some of the most important admissions of deficient progress having been contributed by witnesses who were members of the former Government. I think it sufficient then, in confirmation of my views, to select the following passage of the report:—

"Nothing more strongly impresses an inquirer into the foundation and progress of our Indian Empire than the contrast which, as regards British residence, it presents to our other dependencies. . . . . Statesmen, indeed, like Lord William Bentinck and Lord Metcalfe saw, in the future increase of British settlers, the only permanent prosperity of India. . . . . Even now, although the principle of free settlement has been recognised by British legislation, traces of the old exclusive system are said to linger still. . . . . Your committee recommend the removal of this doubt by legislative enactment."

It is natural to conclude, therefore, that the Government that adopted such an exclusive policy was not likely to have improved the communications of the country, and without roads intersecting the area of 1,500,000 square miles, settlement with the view of production was indeed an impossibility.

I remember, so late as 1849, accompanying Sir Charles Napier (then Commander-in-Chief) in his journey from Calcutta to Simla, 1,097 miles. Our progress up country was governed of course by the means of locomotion, adapted to the various conditions of the gaps of incompleted trunk road over which we travelled. Our palkee carriages were often drawn by coolies, at other times by oxen, and then by horses. In answer to my expression of surprise that such a state of things should exist after so long an occupation of the country by the British, I was told that I should have still more reason for surprise, when informed that the construction of this one road, even so far, had been strenuously opposed by the Collectors of the districts through which the line passed.

The following is the report of the Parliamentary Committee on the state of the communications ten years later:—

"It has been truly said by one of the earliest witnesses, that one of the first wants of a settler is facility of access to the interior of the country. The Indian Government, however, held the country the greater part of a century before a line of road was commenced, even through the most populous parts if India. This is a neglect that even those witnesses who have been connected with the Government of India acknowledge and deplore. * * * 'We are perishing,' says Sir John (now Lord) Lawrence, for want of roads in the plains.' It appears that the roads in Southern India are much better."

I think that I have quoted enough to show the causes which had prevented European settlement in India, and these may be summed up chronologically thus:—From 1757 to to 1813 there was absolute prohibition; from 1813, trade was thrown open, but it was not till 1833 that, through imperial legislation, Europeans were permitted to settle in India. But though advantage was generally and eagerly taken of this permission, indigo planters encountered difficulties, into which I do not, however, propose to enter.

Having thus disposed of the past, I turn with satisfaction to the extraordinary development and progress of commercial enterprise which has occurred subsequent to this epoch.

By the courtesy of Dr. Forbes Watson, Reporter on the Products of India, at the India-office, I have been able to refer to his very comprehensive and important report, dated June, 1877. In it he shows that in the period of the 20 years which have elapsed since the great mutiny, and the transfer of the Government of India to the Crown, India has undergone a profound transformation, which he attributes primarily to improvement in the means of communication brought about by the introduction of railways, and which, as he truly remarks, has transformed the whole face of the country. Thus, in 1857, there were no more than 274 miles of railway open; at this time there are nearly 7,000 miles open. The effect upon the finances of India of this remarkable change in the circumstances of the country has been simply to about double the revenue and expenditure. It is true that expenditure is seriously in excess of revenue; still, the circumstances altogether demonstrate remarkable vitality in all branches of the administration, for the increase of both revenue and expenditure has been accompanied—the reporter shows—by a still greater increase in the wealth and prosperity of the country. Thus, tonnage of foreign and coasting trade has doubled itself; while the exports and imports have increased in even greater proportions, that is to say, exports of Indian produce and manufacture have increased 133 per cent., imports, 163 per cent., and the total trade by 140 per cent.

But not only has trade increased in volume; it has also, as Dr. Forbes Watson states, completely changed in character. He told me that Kashmeer shawls, for example, have ceased almost as an export, a fact which he somewhat ungallantly attributed to the caprice of fashion among ladies. Silk, too, is becoming more an article of import than of export in India.

Remarkable, however, among the exports of the last twenty years is the production of wheat, which has increased 1,320 per cent.

Coffee and tea are classed by him among the recently acclimatised exotic products, the aggregate increase of which is put at 1,456 per cent.

These results speak for themselves. I turn now to the subject of European settlement and colonisation.

In using the term settlers in this paper, I should be understood to mean capitalists and skilled labour; as applicable to culture in the plains, where European manual labour is out of the question. And although, in strict definition, the term "colonisation" may not be considered by some as quite applicable to our circumstances in India, it is sufficiently so to justify my using it when explaining the character of the European settlement in the hill districts, which I propose to you to-night.

First, then, as regards settlement in the plains. The European capitalist, having the command of native labour, can always select for his own residence some healthy locality within easy reach of his estates, while European superintendents, which I class as skilled labour, can direct native labour without extra risk to health, as was abundantly proved to the Select Committee; who speak of the matter in language which has such an important bearing upon the subject now before us, that I regret that time will not permit me to do more than refer to it.

On the other hand, colonisation—or, in other words, the permanent settlement of Europeans in the hill districts of India—signifies their residence in altitudes ranging from 3,000 ft. to 10,000 ft. above sea level, where (according to the observations of Sir Joseph Hooker) climates about the mean temperature of London can be obtained, where the colonist may labour and maintain himself and family in comfort, and where there is no reason why he should not grow rich.

Any one looking at the map of India must be struck with the peculiar distribution of those vast ranges of mountains, that hem in the plains like a wall, from Assam in the east to Peshawur in the north-west, and from that point southward to Seistan, under the general names of the Himalaya, the Hazarah, the Suffeid Koh, and the Suleiman ranges. These form, so to speak, the natural boundaries of British India. Spreading out along their bases are vast numbers of lesser ranges, constituting, in fact, the spurs and roots of the greater mountain masses. These are known under the general term of the sub-Himalayan or hill districts, their climates varying from tropical to European, according to altitude and aspect; their upper slopes covered with forests of cedar, pine, oak, chestnut, plane, and other useful varieties of timber; while, on the lower sides and valleys, productive soils abound, capable of producing European cereals, fruits, vegetables, and flowers.

Other hill districts there are, in Southern India, of the greatest value and importance to Europeans, as offering every inducement for colonisation. On these I will first make a few passing observations.

Both in the higher parts of Mysore and in the Neilgherries to the South, perfect climates can be found, and productive land is attainable on easy terms. Soldiers marry and settle there in preference to returning to England, while the capitalist has been known to make immense profits on the cultivation of coffee, which commands a high price in the London market. Cotton of a superior kind is grown there as well as sugar, wheat, oil, seeds, and hemp; while cattle of a remarkably fine breed, and the merino sheep have been introduced.

Cinchona, too—an invaluable plant for India—has been recently introduced from Chili, by Mr. Clements Markham, with complete success. Its cultivation (principally in the Neilgherrie hills) has now passed from the Government nurseries to private enterprise, and is extending rapidly, and with great profit.

The preparation from the bark, a sort of quinine, is in universal demand. The value of last year's export exceeded £38,000; and in India it is sold at one rupee per ounce. The benefit conferred on the hospitals of India by Mr. Clements Markham is inestimable.

Now, turning again to the hill districts in the north, we find the physical conditions very different from the rolling uplands of the South of India. Bearing in mind that they are the children of the parent mountains, some of whose peaks reach to 29,000 feet, the hill sides of the lower and habitable area are much more abrupt; and the valleys narrower and deeper than in the Neilgherries.

Hence it happens, also, that the soil on these slopes has to be retained by terrace walls, as on the sides of the hills of the Riviera of Italy.

In alluding to the varieties of climate to be found on these hills, according to altitude and aspect, I should have mentioned that there is also another distinct modification which affects materially the conditions of soil and production—if not of race as well—and that is, the degrees of moisture extending over this area, my impression being that the maximum of humidity is found in the south-east, and that it diminishes gradually towards the north-west.

Through the kindness of Mr. Blandford, Meteorological Reporter to the Government of India, I have been able to refer to his first and most interesting report on the meteorology of India, for confirmation of my impression on this point, and I find that, as a rule, this is the case.

With one important break only in the gradation of the scale, at Dharmsala, the moisture having a maximum at Sylhet of 154 inches, and at Darjeeling of 121 inches, diminishes gradually till it reaches a minimum observation of 50 inches at Murree, in Hazarah.

The natural results of moist and equable temperature are abundant soil, clothing the sides of the hills with luxuriant vegetation. An interesting fact, communicated to me by Sir Joseph Hooker, affords an illustration of these conditions. In writing about the cultivation of tea, he says:—"It is a wonderful plant! You have it in the equable damp hot climate of Assam, and in the extreme cool climate of the north-west, but under different conditions. In Kangra you have, I believe, but one picking or 'pluck' of leaves in the year, and your tea is of a fine quality. In Assam you have several 'plucks,' and the tea is coarse and strong in comparison."

As the minimum of moisture is approached—that is, towards Hazara—the effects of a drier climate become apparent; nature seems to recognise the fact by a sterner order of things. The air is keener, and the soil is, in general, poorer, and perhaps on that account more sought after in its culturable conditions.

But notwithstanding this alteration of climate, the tea cultivation has already extended to Hazara, which is the extremity of our hill possessions in the north-west at present.

Now, with regard to the question of Europeans maintaining themselves in the hills, I have heard it objected that the sun heat of the deep valleys would prove too much for them in tilling their own ground, but I hold an entirely different opinion. I used to visit frequently the detachments of soldiers under my command located in the hills in huts (some of them being of the most primitive construction), with the view of observing

the effect upon their health of this open-air sort of life compared with the regular barracks of the sanatorium. I remarked that, after the soldiers had become familiar with the steep hill paths, their favourite pastime was to obtain leave and visit the valleys, in which they would wander about all the day, or they would cultivate their potato grounds below their cantonments. In any case, their health was invariably robust, and, in short, the sun heat in those valleys is not greater than in the south of Europe, while the temperature in the shade is, as Hooker describes it, about that of London; and, I should add, this eminent naturalist passed two years wandering on foot about the valleys of Darjeeling.

I, too, have had some experience of the valleys further to the north-west, and I can confirm his observation that, down to 2,500 or 3,000 feet, there is nothing in the climate to deter a European from out-door labour. This opinion is fully borne out by medical testimony. Indeed, it is the opinion of most medical men that, even in the plains, a man's health is to a great extent in his own keeping; while on the hills, robust health is insured by out-of-door occupation. As troops employed in a lengthened siege acquire a habit of keeping under cover, so do we, in India, insensibly educate ourselves into regarding the sun under every condition alike as our enemy.

At the same time I would not propose that the same localities should be chosen for European as for native dwellings, whose villages are situated, as a rule, in deep and sheltered valleys. This rough sketch of a Himalayan valley, that I exhibit here to-night, is intended to illustrate by comparison the principle which ought, in my opinion, to govern the selection of sites for European occupation.

Assuming the culturable land to lay chiefly about the native village, situated, as you will observe, deep in the valley, the cultivation of such land would be within the reach of the European whose dwelling may be on the same plane, and yet be on the open and airy shoulder of the hill.

As regards the character of the buildings best suited to colonists, I have already mentioned my preference for the rude wooden huts in which I lodged several detachments of soldiers (especially young men arrived from England) in several parts of the hills, in addition to the depôt of invalids quartered in the regular barracks of the sanatorium.

The construction of the latter is, in my judgment, on a wrong principle and too costly. Perched, as a rule, on the comb of some ridge, they are exposed at elevations of 7,000 feet to the cold winds from the snows; while the solid walls establish the means for thorough draughts between windows and doors, up staircases, and along passages; resulting, as I have observed, in accession of colds and chest complaints among the invalids fresh from the plains. The cost of such buildings become moreover a heavy item of State expenditure, and all the more so because it is unnecessary. I remember that one of this class of barracks at Murree, capable of holding about 100 men, cost 46,000 rupees.

Now, the observations which I was able to make of the health and appearance of the troops quartered in the permanent barracks at the sanatorium, compared with the rude huts I have described, led me to the conclusion that the latter were far preferable in a sanitary point of view, and, moreover, entirely congenial with the tastes of the men themselves. The chinks and crannies of the timber huts, though stopped sufficiently to ensure comfort, were yet numerous enough to ensure an equable flow of air, without thorough draught; their cost in no case exceeded 700 Rs. for about 80 men.

This, then, is the class of dwelling I would recommend for settlers in the fine climates of the hills.

I have already remarked upon the productions of these hill districts. In the words of Dr. Hooker "There are abundance of fowls, European and tropical vegetables, fruit, and cattle; besides, all the European and native cerealia of India can be grown." Then there is the ever-increasing cultivation of the tea plant, which, as I have said, is now extended to Hazara. It remains for me only to mention one other product, which does not appear to have attracted the attention which I have always thought it deserved, and that is the vine, especially productive in Chini, where a great variety of grapes are produced in abundance, some of them of the finest kinds, including muscatels.

In the years 1850-51, while stationed at Simla, a little horticultural society was formed, of which I was the very unworthy president, our object being to introduce and encourage the cultivation of European vegetables and flowering plants, and to discover and develop useful native products.

The Governor-General thought well of the objects of our society, and was present at one of our horticultural shows, where a single bunch of grapes from Chini was exhibited by Mr. Edwardes, the Commissioner—a cluster which the Hebrew reconnoitring party in the Valley of Eschol would not, I venture to say, have left behind them, for it constituted the entire burthen of the man who brought it in, filling his kilta, or hill basket, slung from the shoulders, as you see in the sketch. The berry of this wonderful cluster was of a small, black kind, similar to the grape from which the red wines of France are made.

I brought this fact to the notice of Lord Dalhousie at the time, and suggested that a competent wine-grower should be brought out from Bordeaux, to advise the Government on the possibility of establishing the growth of light and wholesome wines for India.

Among other indigenous products exhibited on that occasion, I remember some asparagus of an immense size, found on the northern slope of a mountain between Simla and Kunawur, and some fine Turkey rhubarb, indigenous in Kunawur.

Having now given a sketch of the physical, climatic, and productive conditions of the hill districts situated between Assam and Hazara (that is, the area within our present political frontiers), I propose to offer a few remarks upon the inhabitants of these and the ranges still further to the westward.

Bearing in mind the gradual diminution of moisture in these hill districts, from the south-east to the north-west, I hinted in a former part of this paper the possibility that the altered conditions of atmosphere might naturally be deemed to have their influence upon the human race as well as upon soil and production; and consequently, that what we are accustomed to regard as chance political conditions, are, in effect, due primarily

to established atmospheric causes. Be this as it may, it is certain, as we come away from the south-east, the character and physique of the hill inhabitants alter in proportion to the diminution of moisture, until in the extreme north-west angle, and the western mountains beyond the Indus, where the atmosphere is very dry, these conditions culminate in the Pathan races—the hardiest, most irascible, and most truculent mountaineers that ever held a pass.

Owing to these circumstances, together with the fact that the trans-Indus mountains are as yet beyond our border line, the area of hill colonisation is for the present confined to the peaceful districts between Assam and Hazara, that is to say, between the 73° and 93° of longitude; and if there should be any foundation for my theory, that the perpetuation of vigour in the European race would depend on the avoidance by settlers of zones of excessive moisture, such as are met with in the south-eastern extremity, experience would probably result in preference being given, for colonial settlement, to the districts about Kunawur and Kangra.*

Now, viewing our possession of India as permanent, I confess to an ever-present conviction that God has placed the British race there for some just end; and that, whatever that may be, it is our first duty to work out measures that must obviously direct us to that end, and that, humanly speaking, through the medium of civilisation, in the highest and best sense of the word, education. At the same time, it would be worse than affectation to shut our eyes to coming risks, even in promoting this, our manifest duty. The tremendous strides now being made among the natives of India in every direction, need both vigilance and adroitness on the part of our Government, in steering the flood of progress into legitimate channels. Education among the natives is increasing so rapidly, indeed, that, using the words of Dr. Forbes Watson in his report, "there is conclusive proof that it is already beginning to affect the masses." This fact, combined with the influence of a certain general middle-class wealth, which I know has been springing up of late out of railway and other description of contracts—together with the sudden extension of railway and telegraphic communication, opening up ideal and material interchanges between races and castes which had no previous existence—these are some of the elements that will, I say, demand careful thought and delicate handling in the future of India. Nor can it be denied that, in proportion as these new circumstances become developed, so must the British force appointed to control India, with her 240 millions, be increased. In this view of the subject, however, I am not prepared to advocate any corresponding augmentations of the regular British Army serving in India.

The Indian military expenditure is already aggravated by the system of short service introduced into the army, thereby increasing the transit of troops to and fro between England and her Eastern Empire. I am averse also to anything like a local European army for India, as a useless factor in civilisation. But no such objection would attach to the constitution of a militia for India; and in the gradual development of this principle, I would look for a natural and economical augmentation of the physical as well as moral forces of the governing race, calculated to keep pace with, and regulate, native progress.

I assert, without fear of contradiction, that it is the duty of every Englishman who goes to India to settle—with or without capital—to do something toward the public security, in aid of the Government that protects him and enables him to acquire wealth.

We have been taught to regard the militia of our country as embodying the principle of service in connection with soil and property, distinguished from the service of the regular army. Why should not the same principle obtain among our settlers in India, now becoming so numerous?

It is true that there are volunteer corps in India; but, I submit that the principle of volunteering is not applicable to the circumstances in which we are placed in that country. I have had to give some study to the subject, both at home, and lately in India, for I was asked by the Government there to assist in framing regulations for them. That which is essentially the product of patriotism among the home population of England, and has its roots in every institution of the country, becomes in India a mere feeble expression among settlers sprinkled over a vast area, and separated by alien populations. There are no institutions out there that are dear to settlers as there are to Englishmen at home; nothing to defend but the Government and their own lives. It is manifestly the duty then of every settler to give his service for the public weal, and not for one man to enrol as a volunteer while nine others go about their business, depending upon him and the Government for their safety. Obligatory universal militia service for settlers generally constitutes, therefore, in my judgment, an indispensable factor in the maintenance of our future rule in India. In the hill districts, however, the organisation should assume a more decided form, that of military colonisation, as offering a sufficient substitute for that costly augmentation of the regular army in India which otherwise would appear to be eventually inevitable.

In this I do not advocate the adoption of any radical and inconvenient measure. The Government are already aware of the numerous discharged married soldiers who settle in the hills of India, in preference to returning to England. What I would urge on their consideration is the obvious advantage of (1) bringing all such settlers under a distinct militia organisation, and (2), of transferring to the Reserve, as military colonists, eligible soldiers actually serving with their regiments, men who belong to the agricultural class, with a proportion of tailors, shoemakers, butchers, and mechanics.

To cast these into an organisation for a military colony ought not to be difficult. Their voluntary transfer from their regiments to an Indian Reserve would be the first step of their new existence. Suppose twenty selected men thus transferred, including a steady and intelligent sergeant, two corporals, and seventeen privates; these, with

* I have been fortunate since writing this paper in receiving from Dr. Forbes Watson what I venture to consider a singular corroboration of my views. In a book published by him occurs the following passage:—"During the course of a series of observations made in India on the direct influence of climate on the human body, I found that, after a period of continual rain, as during the monsoon, the blood became deteriorated in a remarkable and striking manner, and that this was no accidental occurence was proved from the fact that it was found to exist, without exception, in every case which I examined.

their families, would constitute a unit of military colonists.

Suppose, then, a suitable locality or position to be chosen for them, and the necessary land calculated for their maintenance acquired by Government, either by grant, or purchase, or by exchange, together with the requisite number of wooden huts (including church and school-house) constructed for their accommodation (or the materials brought to the ground), the detachment of colonists, equipped with implements, stores, and working clothes at the charge of the regimental canteen fund, would then be sent on to its destination, where the men would either construct their own huts upon a given plan, or (should these have been constructed already) at once enter upon the cultivation of their respective allotments, under the superintendence of a settlement officer, whose duty it would be to supply seed for the first year, with the necessary live stock. In any case, they should continue on the roll of their regiment, and be maintained as effective soldiers for two or three years, when, like layers duly rooted and able to support themselves, they would be severed from the parent plant, and their transfer to the Indian Reserve completed. Their pay during this period of probation should continue till means of self-support became available.

The first section fairly started, might be followed by another, and a third, and a fourth—all four from the same regiment, on the principle of comradeship—but at sufficient intervals of time to allow the previous sections to take root in the soil, say an interval of two years between each section.

Two sections, forming a subdivision, should be commanded by a subaltern, and two sub-divisions by a captain, all officers being colonists and belonging to the Reserve.

Thus, a company of 80 men, in four sections of 20—the formation extended over a period of eight years—might be furnished simultaneously from every regiment serving in India, without weakening it, or creating strain in any branch of the public service.

I have entered thus far into details of military organisation, as they are inceptive and explanatory of a novel service. The distribution into battalions and larger bodies would follow on known principles.

It would be for the Government to determine whether the children should not be taught in village schools, in preference to congregating them at asylums; the object of those admirable institutions, established by the late Sir Henry Lawrence, being for the health and training of orphans and the children of soldiers serving in the plains; whereas, for the children of colonists in the hills, I would provide home teaching, so as to identify and associate them with the soil, as an essential element of their training. Education being, in fact, the foundation of prosperity in a community, all matters connected with it would have to be carefully considered and worked out, with other details, such as the care of the arms, ammunition, and accoutrements in charge of each section, and the storing of camp equipment at convenient points of assembly at the foot of the hills.

I will now touch briefly upon the agricultural economy, which I would have grafted carefully on this military stem, to cause it to flourish and bear fruit. When I undertook to prepare this paper, I searched anxiously for some example in history that would bear me out and support my views. The principles of Cromwell's settlement of Ireland were contrary to my ideas of justice. The Cossack colonies of Central Asia are equally objectionable, from their aggressive policy. The Greek colonies left by Alexander in and to the north of Hazara (whose descendants we suppose to be the Siah Posh Kaffirs of to-day), go only to prove one fact, after a lapse of 2,000 years in these hills, and that is, their unmistakable European origin, unimpaired in its vigour.

But I have found in Paget's description of the old border corps of Hungary and Transylvania an exact exposition of my views; indeed, a remarkable parallelism, both of principle and circumstances, exists with that belt of military colonists that extended like a wall along the Turkish border of Hungary and Transylvania, and that which is now proposed for the hill districts bordering the north of India, inasmuch as that this Border corps was calculated as well to keep the Hungarians themselves in order as to repel the Turks, while the military colonists of India would equally control the populations of the plains and serve in repelling invasion, if needed.

But the parallelism is capable also of being carried into the details of interior economy, which are the more useful because they have always proved completely successful; for example, land was held by the Austrian border corps, as fiefs, on the tenure of military service. Each fief was bound to furnish and maintain, according to its size, one or more men at arms. The eldest on a farm, or fief, was the "house father;" he, with his wife, the "house mother," had the direction of the farm, the care of the *ménage*, and the right to control the members and to watch over their industry and morals. On the other hand, the rest of the men of the family had to be consulted in any great changes, such as purchases and sales, and at the end of the year they might demand an account of expenditure from the "house father;" and if he were habitually drunken, or immoral, he would lose his right to the position which age would otherwise give him. So long as he set a good example, the family owed him obedience and respect. The fief itself, and the implements and cattle necessary for its cultivation, could not be sold, and every member of the family had a right in them. Any excess of cattle and production might be sold, with the consent of a superior officer.

Every member of a family was, of course, encouraged to marry; and when a family became rich or too large, it was allowed to divide, and the party separating received another fief, either by grant or purchase of "überland"—that is, land not yet allotted. Such as left the frontier service had no right in the property of the family. The militia drilled four days a month, from October to March, and at long intervals the whole regiment encamped out and manœuvered. In times of public danger the border corps could turn out 200,000 under arms, while 40,000 men were always on duty. Similarly, we might, by degrees, have a proportion of our military colonists on duty at stations in the plains nearest to their locations.

The border family had to perform certain civil service also; one day per annum for every English acre for the State, in the repair of roads, bridges, draining, regulating rivers, repairing public buildings, &c.; and eight days per annum for the village; as in building churches and school houses, keeping the village roads in order, cutting wood for the school, and working the farms of widows and orphans.

The borderer's chief tax, besides the furnishing uniform for a man at arms, was a land tax, amounting, for an entire fief of 36 to 50 acres, to from 15s. to 30s. per annum. Government found arms and ammunition, shoes and accoutrements. Tradesmen and artisans paid according to their property. The border officers had many duties peculiar to the position of feudal supervision; they gave consent to marriage. We find among them "officers of economy," to direct the farming processes; architects, surveyors, &c., for the care of the public property.

These laws are framed in a spirit of paternal kindness, having in view the encouragement of industry, inducements to accumulate wealth, and for the promotion of order and agreement in families; besides institutions for the maintenance of the widow and orphans, and for the education and improvement of the people.

The administration of justice seem to be yet more favourably organised. The first tribunal in civil cases was formed by a Lieutenant of Economy, a Sergeant-Major of Economy, and two House Fathers, chosen by the Colonel. Their judgment had to be confirmed by the Captain. In criminal cases, however, the court martial composed of officers, non-commissioned officers, and soldiers, decided.

It is impossible to study this institution and not be struck with its power and utility, and with the wisdom and philanthropy with which many of its regulations were conceived; and, to a military man, whose idea of the value of a country is in proportion to the amount of applicable force that can be drawn from it and maintained by it, it must appear perfect.

We have seen that the Borderers drew their own resources entirely from their own labour, for the taxes they paid would more than refund the cost of their arms and equipment: altogether, I have found nothing in history that so nearly meets the conditions of military colonisation in India, as that remarkable organisation which stood the test of several centuries.

One important result would certainly follow upon the establishment of military colonies in India; that is, the absorption within its healthy and industrial sphere of that increasing class known as poor Eurasians. At the same time, colonists belonging to the Reserve should not be permitted to marry other than European women.

There is still one point for consideration. I acknowledge that the question of the acquisition of land *en bloc* is beset with difficulties. But are these insuperable? I entertain a belief, which I hope is not too sanguine, that the Government, if disposed to favour the scheme of military colonisation, would find a way of carrying it into effect without injustice to the present holders of lands. It is true that the valleys are, as a rule, already occupied and under cultivation, especially towards the north-west, where the culturable parts become scarcer, and the soil poorer.

We have it in evidence, however, that there is no want of waste and highly productive land in the hills of the south of India. The same is said of the hills about Darjeeling. But it is towards the north-west that I would prefer to see military colonies established; and I give the following quotation, as a straw thrown on the surface of the subject, to show the direction in which available land lies. It is an extract from a work on "Kooloo, Lahoul, and Spitti," by Captain Harcourt, Assistant-Commissioner in the Punjab. On the subject of the transfer of waste lands, he says:—

"As a rule, dissentients are always to be found, who object to the entry of European settlers on 'common' lands. I think some steps might be taken to facilitate the acquirement of lots by Europeans who desire to settle in the valley; for it appears to be a monstrous pity to see such thousands of acres, which might easily be utilised, and which are never touched by the people, lying within sight, but quite beyond the reach of the would-be settler."

But military settlement, after all, would be no novelty to the Government; for certainly one, if not two regiments of Ghoorkas—a hardy Mongolian race—were allotted lands, within the last 20 years, in the neighbourhood of Chumba, where their families now reside and cultivate the soil. I have no doubt that these lands were acquired by Lord Canning's Government under equitable and satisfactory arrangements, and I entertain as little doubt that similar transfers might be effected in the case of European military settlers, and that the Government would be repaid their first outlay eventually by a light and just taxation, as well as by the more immediate saving in the transport of soldiers between England and India.

Such, then, is the scheme of military colonisation which I advocate for India. I say nothing here concerning that section of mountain ranges in the extreme north-west, and beyond the Indus, because the question is purely military, but I conclude with the reflection that if it is our mission (and I have no doubt it is) to engraft Western civilisation upon India, this can only be done by the English race taking root upon the soil; and be it remembered, that "when a strong man, armed, keepeth his palace, his goods are in peace."

DISCUSSION.

The Chairman said—I beg leave to offer some observations, involving points of political economy, in support of the important objects of General McMurdo's paper. Mr. Robert Rawlinson, our sanitary commissioner in the Crimea, has observed to me that on a view of the territory there, of highly cultivable land with a sparse and poor population, and a comparatively miserable amount of produce in its present condition, and the great amount of capital expended there upon Sebastopol on its fortifications, its guns, its great barracks, and in the maintenance there of an unproductive mere fighting force—that had that capital been expended by the Czar in opening up the country by roads, and in fitting the territory for good colonisation and production, by an efficient working force, he might have obtained far greater power, and, indeed, effectual power, of withstanding the assaults of all the forces of the western states on the field there. I have confidence in the judgment on

which the observation was made; and I submit that, when duly considered, it would afford a lesson on the great question before us, and that capital would be far more economically expended on well-made lines of productive settlements in India, wrought by working military forces, which would give far stronger, as well as cheaper, defences than the common-place lines of fortified camps and mere barracked fighting forces. The fighting time of the mere common fighting soldier is as days against years of unproductive and detrimental barrack detention. My friend, the late Field Marshal Sir John Burgoyne, was wont to enforce to me that the corps of sappers and miners, as a constantly working force, was, notwithstanding the higher pay of officers and men (results considered), the cheapest fighting force in the army, and I believe no doubt it was so, and that working forces which are fighting forces are, as a rule, the most economical. And we are now advancing upon conditions which will render the general constitution of our army, upon the principle of that combination of working with fighting service, more and more necessary for security as well as for economy. Now the objections to the measure before us, made by practical administrators of the old school in India, have been, in short, general and peremptory allegations that neither are our soldiers fitted for settlement nor are the climates of India fitted for settlement by Europeans. As made in their unrestrained and superficial generality, I, for one, should admit these objections to be conclusive. It may, however, be shown that we know better than the objectors do the depth of the foundations for their objections, or they would bestir themselves for their removal. First, as to the unfitness of the common soldier for settlement. The old Duke of Wellington stated that his fighting force was made up of the dregs of the population, and that in itself it was unfitted to bear either victory or defeat. Nor with the progress or the demand for labour, and the increase of wages in civil life, are we left with anything but dregs now. This is shown by some six thousand desertions, and twenty thousand court-martials annually, and we have in the army a large infusion of convicted thieves. Hence, whilst the restriction of the use of the lash is lamented, we have in Parliament the power of branding or marking deserters demanded as necessary. Mr. Trollope, in his recent book of travels in South Africa, says: "In one place close at hand, not a hundred yards from the door, were pitched the tents of a detachment of soldiers who were being marched up to the border between Natal and the Transvaal. Everybody immediately began to warn his neighbour as to his property, because of the contiguity of the British soldier. But no one warns you to beware of a Zulu thief, though the Zulus" (*i.e.*, the savages) "swarm round the places at which you stop." Such, certainly, is not the material for colonisation! The prevalent vice is inebriety, and inebriety is a wasteful element in force for tropical climates. I, some time ago, however, received the evidence of old soldiers—campaigners—that two educated and well-conditioned men had the efficiency of three as fighting force. It was, indeed, an axiom of Buonaparte that, whilst physique was as one, morale was as three, for war. These axioms are submitted as *a fortiori* applicable to settlement and colonisation. What is especially wanted for colonisation in India is a force of intelligent, sober, and respectable men, men who will not only work themselves, but guide the natives in working, as did the Roman soldiers when they held this country, as we see by the remains of their roads, their sea walls, and their colonies. As a working force our line force in the mass may be taken as of little worth, whilst as a fighting force it is relatively inferior, inasmuch as the new arms of precision require more and more sobriety, steadiness, and intelligence to wield them successfully, whilst in the mere dregs, do what you will, we are getting less and less of those moral and economical qualities. There is increasing difficulty in getting men with the very rudimentary education needed for service as non-commissioned officers. There can be no doubt, however, that if the business of settlement were properly set about, a sufficiency of such select men may be found as fast as space can be found for them. General McMurdo states that a population of such men may be selected from most regiments. I believe it may be so, for in my own time we found the best men we could get then as masters of our union-houses were of the *élite* of non-commissioned officers. But more settlers, and I venture to believe of a superior class, might, with proper inducements, be obtained from the class of men of whom General McMurdo has been so distinguished a commander—the volunteer force, of whom it may be said that they are superior as a fighting force, for they beat the barracked force in small arms, and in large arms, and in discipline, whilst from them a superior working force might be obtained. A supplemental force might also be obtained from amongst the youth trained on the mixed physical training of the district schools, whose exercises we have witnessed, and who already are found to succeed particularly well in the colonies, where a large proportion of them obtain respectable middle-class positions. Settlements might be so constituted as to afford acceptable society to the colonists amongst each other, as well as a collective fighting force when needed. The objection to such settlement on sanitary grounds admits of more complete refutation than the objectors can be aware of. I can state, amongst other points, that the death-rates amongst the working force, on railways and other public works, working in the open and the full heat of the sun, are greatly lower than the death-rates amongst the mere fighting force sheltered and kept in idleness in barracks. There are, however, according to the testimony you have heard cited of Sir. Joseph Hooker, spaces available for settlement, in the first instance, with climates equal to that of England. Others there are that may be made available by works of sanitation, on which I have heretofore cited the well-examined example in Algeria, where the death-rate, on a site in which three sets of soldiers and three sets of settlers had been decimated, had been reduced from more than sixty in a thousand, to less than thirteen in a thousand, and where the birth-rate was made higher than the death-rate, and crops of robust children were obtained for succession. To obtain sure ground, experience shows that settlements should be preceded by competent sanitary reconnoissance, and be accompanied by sanitary supervision. I speak from some experience of emigration and migration under the Poor-law Amendment Act, as to the need of such supervision. Indeed, this is exemplified in the great success which has attended the Coolie migrations now marked by an increase of Coolie emigration, of which it may be observed that it has been held heretofore as an indisputable dogma, that the climate of the West Indies was utterly unfitted for labour or settlement by any other than negro races. Now, it appears from returns I have obtained, that the death-rate of the Coolies, chiefly from Madras, who though not what we call a white race, are far from the Negro races, and were amongst the alleged impossibles, is, under most successful sanitary superintendence, being not above one-half the death-rate prevalent amongst the free Negro labourers and squatters, as far as we could ascertain, under a sanitary commission to the West Indies. In India, the proofs of the fallacies of such insanitary dogmas are increasing. I expected here to-night the presence of the father-in-law of a robust fourth generation of indigo planters, and scattered instances of the like promise of continued succession already sufficient in number of themselves as evidence, are increasing. Promises of sanitary normas are arising even in India, where, under extensive insanitary rule, they would be the least expected. Here is one, from the report of the officer of health of Calcutta for 1876. "In the European Orphan Asylum (there in Cal-

cutta), where children of all ages are maintained, in a mean daily number of 60, there have been during the last nine years only three fatal cases of illness; while in the native town infants die as they die only in the most fatal countries. European infants, with 5·8 per cent. of deaths in the year, enjoy in Calcutta a degree of vitality which surpasses that of the most favoured spots elsewhere;" *sic* in the official report, that, is to say about one-half the common death-rate of children of the school ages in London! But here is another furnishod norma. Tho reported death-rate in Fort William, with a population of 2,800, is stated to be 4·1 for males, 5· for females per 1,000 of the entire population, military (934 European troops), civil, and native, that is to say, about one-quarter of the general death-rate in London! Fort William is stated to be a very fine position, but this is a death-rate equal to my norma of a prison, and I give it as stated, yet as requiring confirmation. In the hill stations there are too many deaths from foul air diseases, nevertheless, even under imperfect sanitary rule, the highest death-rate there, 13·87, is lower than the former death-rate once deemed passable in the home army, viz., 17 per 1,000 in the Line. At Dugshai the death-rate, with exceptional cases, has been 7·55. I might go on to show that, under advancing sanitary rule, it might be almost safe to say that the plain stations are beginning to overtake the hill stations in health. On the other hand, it is to be noted, as a consequence of insanitary rule, which should be the subject of Parliamentary inquiry, that, according to late accounts, in a review by the Lieutenant-Governor of the Punjab, there has been an increase of mortality from fever of a malarious character, on account of which the death-rate rose from 21 to the unprecedented rate of 72 per 1,000, chiefly due, as stated, to the super-saturation of the soil, and the creation of stagnant marsh surfaces, as has been elsewhere extensively done by insanitary canal irrigation. The instance is one showing the need of increased sanitary supervision, and of sanitary reconnoissances, for the sake of the natives as well as for settlement; and, indeed, settlement itself is to be advanced for the sake of the natives, and for their protection, under the rule of an empire which, with all its shortcomings, gives the masses security and freedom, and elements of prosperity and of civilisation such as at no time before was ever possessed in that part of the globe. The necessity for attention to sanitary questions with armies in the field, is again brought out by the gross neglect of the Russian and Turkish armies, where filth, starvation, neglect, and disease in excess—putrid typhus—have been destroying soldier and civilian alike, the lessons taught by the British Army Sanitary Commission in the Crimea, 1855-56 57, having been thrown away. The Americans, in their Civil War, and the Prussians, in their recent wars, saved their fighting power by attending to sanitary matters.

Mr. Maitland considered that the paper might be divided into two parts, viz., the commercial benefits to be derived from European settlements in India, and the advantage of forming there military colonies, such as had been formed on the frontiers of Austria. Whether it could be done with safety to the lives of Europeans was a question upon which he did not speak with confidence, though he had lived in India and had paid a short visit to the hills, and he would leave that matter to those who understood it better. There could, however, be no doubt of the general advantage such settlements would confer on the commerce of India. Of course, in the province of Assam, in consequence of the greater moisture of the climate, Europeans could not be located so successfully as in Darjeeling and other northern districts; still, the settlements there had been doing enormous good to India. Lately, in the *Calcutta Englishman*, a critique upon a long report to Government on emigration into Assam had appeared, which showed what had been done. Not very many years ago, but few pounds of tea were exported from Assam, while the estimated export from that province for next year was 32,000,000 lbs., of the value of £3,000,000 sterling. In 1876 alone, 3,400 Coolies arrived there irrespective of the local labour, and the total number of coolies who had been brought there with benefit to themselves from other parts of India where they were not so well off, was 190,000, settled there with their wives and with children growing up about them fully employed and well paid. There were now 800 tea-gardens in Assam, 37 of which had been formed in tho past year. One company alone had 7,200 imported coolies in their service beside 32 British. If so much had been done in one province, what might, hereafter, be the result in other parts of India if properly colonised? They knew what was being done in the northern districts, and the benefit of military colonisation appeared to be self-evident. He had stated his opinion before a committee of the House of Commons that every man that went out to India capable of bearing arms, wherever he might go, would add one to the garrison of India. Probably there were now in Assam 1,000 British in the prime of life, men accustomed to the use of the rifle, and the benefit to India if that instance could be multiplied 30 times he would leave the meeting to judge. One of the objections to such settlements made before the committee he had mentioned, was that isolated settlers would invite attacks from the hill tribes; but the Pilgrim Fathers, on landing in North America, invited attacks from the red men, and when the English first set foot in India, although they endeavoured to get along quietly as merchants, they were attacked before long by Suraj-u-Dowlah; and the Black Hole episode followed, but for all that they had maintained their position in India. There really could be no objection to the settlement scheme from that point of view, and as every man who went out would add one to the present garrison, so every child born there would add another in the future. He could speak personally, from what occurred in 1857, to the advantage of having men in India able to act as volunteers; to give one instance, the small house at Arrah was defended against the Sepoys by a man who was neither soldier nor sailor, but a railway engineer. With regard to the questions whether the military settlers would be able to bring up their children there beyond the second or third generation, and whether there was plenty of land to be got for them on equitable terms, probably others present could speak better than himself, but it was certain that every man who went out and worked well and hard would be a benefit to India. General McMurdo had said that probably immense profits could be made by the cultivation of tea and coffee in the North-Western Provinces, but it was to be feared that was not so to-day, whatever it might have been in 1869; still, although large profits might not be made by tea and coffeo cultivation, settlers would prosper, and might cultivate with advantage those and the various other products which had been mentioned.

Mr. Hyde Clarke admitted that it was a melancholy reflection, how little had been done by Englishmen in India; but, when their discouragements and disadvantages were considered, hope must be felt for practical results from the scheme advocated in the paper. Charges had been often made against the old Government of India, the East India Company, of throwing impediments in the way of Europeans spreading themselves over the country; but they must consider the conditions of the country at the time, the wars in which they were engaged, and the way in which they were opposed by the French and Germans, who enlisted in the service of the native princes, and were always ready to foment aggressive wars against us. It would, therefore, have been very dangerous for them to expose India to persons who might have given way to the more tempting political rewards which offered themselves to Europeans of ability and audacity; and it must also be borne in mind that it was not until a comparatively late period—when, by means of our exertions, the country had been pacified—

that it was possible to give Europeans the chance of penetrating into the country. In speaking, too, of European population in India, it must be remembered that that population was not exclusively English, but included men of all nationalities. Since the opening of the Suez Canal, the ruffianism of the West had poured itself into India, and they might look forward with some anxiety to the way in which the European population would probably be recruited from the lower classes of the maritime cities of Europe. Care would have to be shown in increasing the European population of India, and General McMurdo's paper was especially valuable, as pointing to the means of giving India a suitable English population to counteract the vagabond element which might settle there, and disturb the operations of our own Government. It had been said there was no scope for Europeans in the higher regions of India, but when in Assam (which could not be considered particularly favourable) 1,000 Europeans had been located, and employment given to 190,000 coolies, great capabilities must be looked for in the northern districts. Situations would be found in the healthy regions of the hills where Englishmen could thrive and increase, and where they would have opportunities cf founding suitable industries. In 1858 the tea industry was in its infancy, and it was said before the Committee of the House of Commons that it would be impossible for Englishmen to find means of substance in the hills, but tea was now largely cultivated in Darjeeling and Sikkim and extending along the range referred to by General McMurdo to the borders of the frontier. The tea cultivation alone had been the means of raising up a small independent population, and if attention had been turned at that time to the subject of military colonisation, and only 1,000 men sent out yearly, there would now have been a large independent population there. But prejudices existed against such a colonisation from what had taken place with ourselves, while the system of the Austrian borderers had been lately abandoned on account of the difficulties and dangers attending it, dangers and difficulties which it was considered would prevent the application of such a system to India, particularly among our own population. A free passage to India and back was given now to every soldier, but soldiers might be offered as a bounty, besides their free passage out, the means of obtaining a competency in India, on condition of their giving three years' service in the regular army. A good class of recruits might in that way be obtained. As to the details of carrying out the plan, there were many more expedients than those laid before the meeting. Men might find employment in the hills in many ways. A large number of non-commissioned officers had gone up into the hills, and had been employed in the plantations, others in their trades, and some in small trading pursuits. This scheme had not a mere military object; it had a civil claim, to attain which it was well adapted, and it had, in fact, been adopted by many of our most flourishing colonies. The system would be that emigration would be assisted by bounty, and the emigrants would be maintained at no appreciable expense to the public, as they would still be in the military service for two or three years, until they were able to provide for themselves. Then, when the men were able to maintain themselves and their families, they would be the means of giving employment to others, and perhaps inducing their relatives and friends to go out and settle, if the district were suitable, and had resources, as was the case in Australia and the North American colonies. Plans for military colonisation had often been advocated, and it would, in an economical point of view, be the best thing for India, so as to build up there a system of self-remunerative defence against exterior attack, and it would, at the same time, be the means of maintaining the internal peace of India. Not only would those advantages be obtained, but every man, besides being an addition to the military garrison of India, would be the means of promoting its civilisation. Cognisance must be taken of the difference between the hills and plains. The hills were occupied by tribes possessing different characteristics from those of the plains. They were more ready to assimilate themselves to the English than the men of the plains, and a further military resource would be furnished by the aboriginal tribes occupying the hills. There was no ground for the suggestion that a European population could not be permanently established on the hills, where the climate was not pestiferous, and there was no higher rate of rainfall, even in the Eastern districts mentioned, than had to be encountered by our population in other parts of the world. There were higher rates of rainfall, or quite as high, in these islands, as in those districts. It was very difficult to obtain data with regard to the descendants of Europeans in the hills. The population in Darjeeling, for instance, only dated from 50 years ago, and the children who had been sent to this country had not returned, but there were examples of two generations of healthy Europeans there and in Sikkim. Certainly nothing discountenanced the possibility of Europeans maintaining themselves in a climate which Sir Joseph Hooker had stated from his own experience was just the same as that of England; the productions were the same, and its was contrary to all geographical experience to suppose it impossible to maintain a permanent European population there. It was most desirable that public attention should be drawn to the subject. At one time the Government had actually sanctioned the establishment of cantonments for European troops in the hills, but unfortunately the project had not been carried out, or by this time there would have been a large European population there.

Mr. Read said the settlers in the hills had a very just complaint against the Government on the question of the land sold to them. Lands were purchased or acquired by transfer and then colonised, but unfortunately the Government had now vetoed that, and the colonists complained very bitterly on the subject. It would be desirable that that matter should be engrafted on the paper. He would simply hand in the papers with which he had been entrusted, which would give something like a history of the whole matter.

Colonel Rathborne considered that if we meant to remain in India, we must do as other nations had done who had gone there before us, and strike our roots in the country. As long as the English remained a small minority in India, there would always be cases, such had recently occurred, of native papers by the dozen preaching the possibility of "kicking us out of India." The objections to the possibility of doing what was proposed when examined would be found to be simply a farce. It had been urged many years ago that it would be utterly cruel on the part of Government to induce Englishmen to go to so unhealthy a climate, but Englishment went to New Orleans and to the West Coast of Africa, and they were all at the same time sending out their own sons and nephews to make their fortunes in that climate. It had been said that their race could not reach the second generation in India, but the races which had gone there before them had survived. The Parsees came from Faristan, a cold climate in the North of Persia, but they had lived in India very well, had married native women, and brought up their progeny.

A Member—And the Armenians also.

Col. Rathborne—The Armenians also came from a cold climate, and yet Englishmen, who went over the whole world, could not survive there! The whole thing was absurd. The healthiest men in his regiment were invariably those who were out all day in the saddle hunting, when they had no duty to do. What had to be done was simply to adopt the best measures for increasing the English popu-

lation in India. Not only would a military force be brought to the service of the State by these means, but the settlers would mix with the natives and have opportunities of knowing what was going on. Any planter could give the Commissioners an infinitely greater amount of information than they could pick up otherwise, because it was only those who continually mixed with the natives who thoroughly understood them. The Government would have the means of understanding the natives better than at present, and, provided the settlers treated their coolies and labourers well, it would have, not only the European masters to call upon, but their men into the bargain.

Mr. Ward said that the settlers should be located on large tracts of land, as small allotments could not be so cultivated as to pay. Many lucrative employments could be followed in India, though, looking at the state of the tea market at present, it would be found that it would not pay to cultivate tea in India in competition with the China trade, as it could not be produced there at the same cost. The production had already increased from 3,000,000 to 30,000,000 lbs., and the market was even now swamped. There was only a limited demand for it, and it was delusive to talk of the thirty-fold increase which had been suggested. It should not go forth that tea cultivation could go on extending in India *ad infinitum*, though, no doubt, it was remunerative if kept within limits. Coffee growing, too, would be found to be a failure if recklessly extended. Cinchona plantations had also been suggested, but in many cases they had been found not to pay, and large sums of money had been lost in that cultivation. Suggestions which could not work practically should be avoided. At present an immense amount of native labour was available in India at native rates, and if cargoes of men were sent out what could they do when they got there? Clearly, they could not work against the native labourers, of whom there were already more than sufficient. Engineers were now refusing offers to go out to India, because they could do better elsewhere; and if the *élite* were wanted as settlers, they must be offered fair remuneration. Occupation could be found for only a limited number of men as supervisors. With regard to the permanence of the settlements, Englishmen always felt compelled to send their children home, simply from moral considerations, and they generally stayed; then what became of the chances of successful colonisation?

The Chairman pointed out that provision for education in every settlement was implied.

Mr. Ward said that at all events the journey home would always be considered preferable in point of health, visits to the hills having been found inefficacious for the restoration of invalids. As the great object of the Society was to bring practical subjects before the public, nothing impracticable should be allowed to go forth.

Mr. Maitland explained that he had not intended to advocate a thirty-fold multiplication of the tea cultivation, but the increase to that extent and settlements of Europeans, if employment could be found for them. He had told the Committee of the House of Commons that in a few years we might become independent of China in that respect, but had never contemplated going on at such a galloping rate as multiplying 30 by 30.

Dr. Murray thought the paper would hardly be complete unless the medical as well as the military aspect of the subject were given. No doubt a fine country existed on the southern slope of the hills, but on the other side was a succession of barren mountains, from which poured streams of melted snow, which were used to irrigate the few terraces of cultural land, the climate being quite dry. The only level land was well occupied, but on the small terraces the inhabitants were scanty, while forests and jungle were abundant. Besides, there were no proper roads, and such as existed were closed for three or four months in the year by snow. Such a country was scarcely a field for European colonisation. In the plains skirting the hills, such as the Terai, there was plenty of most fertile soil, but the climate was deadly to Europeans; and at Dehra there were places where a few people could live, but they generally went up to the hills, while the villages were as hot as the rest of India. Great difficulty would therefore be experienced in finding land for the settlers which would produce crops sufficient to sustain themselves and their families, for whereas the level land lay too low to be suitable for Europeans, higher up the hills, where they could endure the climate, there was no land for them; anywhere above 4,000 ft. elevation was habitable enough, but there was always the difficulty of finding sustenance to be met. As to rearing young soldiers there for the good of the country, he did not know where the women were to come from, and did not consider it desirable to mix the races, his experience of the half-castes not being satisfactory. European children were not found to grow up so strong there as if reared at home, where, indeed, they were nearly all sent for the sake of health and better associations.

The Chairman said, to answer the many objections which had been made to the paper would imply discussion on particular trades and systems. Colonies, in many cases, had to meet failures of all sorts, but they generally continued to prosper notwithstanding. No doubt the difficulties in India would be enormous if care were not taken to select a good class of men for sending out.

General McMurdo said—In thanking the meeting for the reception given to the subject of my paper, I will reply briefly to some of the remarks which it has elicited. Taking the last speaker first, I would point out that it is not proposed to carry colonisation to the upper and further Himalaya, nor yet to plant it in the Terai or lowest hill area, which, although the soil is most productive where cleared of jungle, is fit only for native labour employed by the capitalist residing in some neighbouring healthy locality. The colonisation area indicated by me is the habitable area from 2,500 or 3,000 feet upwards, say, an average altitude of 6,000 feet. As to the crops not being deemed sufficient for the support of Europeans, there would appear to be some misapprehension. Speaking not only from my own knowledge, but from study of the evidence taken in 1859, the valleys already support dense populations, while there is abundant testimony of the existence of waste or common lands still available for settlement on just and equitable terms. That the soil is most productive, needs no other authority than Sir Joseph Hocker, already quoted. The fact that there are at the least two millions of inhabitants in the two valleys of Kashmir and Nepaul may serve at least to afford some idea of the populations that the soil of the hill districts will support generally, and what is sufficient for 100 natives will surely support 50 Europeans; for the sides of the hills afford grazing for cattle of all kinds. With regard to the observations of Mr. Ward on the alleged over-extension of tea cultivation, re-action from the high (I may say fancy) prices ruling in India would only be a natural result. That there are almost unlimited markets—some of them as yet untouched—is well known. But then, growers must be satisfied with less magnificent profits than they have hitherto enjoyed. I am surprised, however, to hear that cinchona should be cultivated at a loss; my authorities for holding an entirely opposite opinion being Sir Joseph Hooker and Dr. Forbes Watson. Both of these gentlemen (separately) make the same statement, viz., that the product (as naturally it must be) is increasing in demand. As regards education for the children of settlers generally, no necessity ought to exist for sending them to England, while schools such as are at Simla and Darjeeling exist. I can see no reason why a really good public school, or

two, should not be established in the hills of India; to be followed at no distant time by a university. Referring to a remark from Mr. Hyde Clarke, I wish to point out that the abandonment of the ancient Austrian Border Corps was not due to any inherent defect (for the organisation completely accomplished its object), but to the fact that the Hungarian kingdom had become the the highest factor in the Empire, and the Hungarians naturally objected to the continuance of an institution that had been employed to keep them in check. The Chairman mentioned also the difficulty which he apprehends might arise in obtaining really eligible men for colonists from the ranks of the army. Certainly, the numerous courts-martial afford only too much room for this doubt. I can assure him, nevertheless, that the ranks do contain a wonderful proportion of men fit for colonists; men who are steady, self-reliant, industrious, and belonging to the agricultural class. While I admit the doubtful circumstances that usually attend the enlistment of the British soldier, my subsequent experience of him has convinced me that they are often accidental, and that his evil communications are underlaid by good qualities. I can guarantee a quota of excellent colonists from each regiment as a foundation, at all events, of a military colony.

Votes of thanks to General McMurdo, for the paper, and to the Chairman, were then passed by the meeting.

The following extracts are taken from a letter from the Rev. J. S. Woodside, American missionary, on the subject of the colonisation of India, to Dr. Archibald Graham, of Edinburgh, and are published here by request:—

"I beg to say that I see no reason whatever, either from climate or any other cause, why well-regulated communities of Anglo-Saxons should not become permanent in many parts of India; in such places, for instance, as Kashmir, the hills to the north of the Punjab, parts of Gurhwal, Kumaon, Darjeeling, on the high lands to the south-east of the Brahmaputra, and in many other places. Such colonies, to succeed, should be composed of honest, industrious, God-fearing men and women, whose Christian character would command the respect of all classes, and whose sense of right would teach them to respect the rights of others. Give me a community of such men and women, and I will guarantee its ability to maintain itself; and, not only so, but to become eventually the right arm of power to the Government of the country. I know it is a popular opinion that the descendants of Europeans cannot live in India, but I think we have really not sufficient data upon which to build an opinion. . . . The Anglo-Saxon in India, as in every other country under such conditions as those I have indicated, can live, and will become a great regenerating power in that country. The process has begun which will, at no distant day, attract the attention of capitalists to India, and we require but the capital and intelligence of such men to develop such resources in India as the world has never dreamt of. The valley of the Dehra Doon now contains from 90 to 100 families, most of whom remain in the valley all the year round. I resided there from 1853 to 1859, and again from 1865 to 1873, and during all that time I enjoyed excellent health. There are positions of the valley that are very unhealthy. These for the present are not likely to attract European settlers, but the greater portion of the valley is most salubrious. Tea, silk, and the rhea plant are the three great industries likely ere long to attract public attention to the Doon. The extension of these will require European enterprise, and I doubt not we shall soon see a large increase in the number of European residents amongst us. To all such, if they are only good men and true, I shall give a hearty welcome, and shall always be glad to place such information at their disposal as I myself possess."

AFRICAN SECTION.

Tuesday, March 19; Sir GEORGE ELLIOTT, M.P., in the chair.

The Paper read was—

EGYPT: ITS COMMERCIAL CHANGES AND ASPECTS.

By B. Francis Cobb.

It seems almost like a piece of presumption in the limited time allowed for a paper in this Section to attempt to give even the briefest summary of the commercial aspects of this wonderful land; a land full of incongruities, of inconsistences, and surprises, where mighty engineering works of thousands of years ago look down upon the Suez Canal, the work of yesterday. The traveller landing at Suez, instead of being appalled by the vast dreary desert which faces him, turns into a little wooden house on its margin, and telegraphs to Shepherd's Hotel to secure the requisite accommodation for his party. The arrival at Cairo from Europe has been aptly described by a recent traveller as a sudden jump into the middle of the Arabian Nights. Pyramids and railways; rock tombs, temples, and telegraphs; hieroglyphics dating from the time of Abraham, and the most approved cotton gins of modern manufacture, are found almost side by side, and the dragoman calls one at an early hour to ride out from the umbrageous foliage and avenues of Cairo to look at a petrified forest. The most wretched mud huts, which one might suppose at first sight to be erected for the sole purpose of drying dung upon, are within easy distance of the Khedive's Italian Opera, and the dryed dung or gilleh is of vital importance to the inhabitants of the hut as fuel to enable them to cook their food the following day. The following description from Gibbon, stated by the historian to have been given by Amrou, its Saracen conqueror, to the Caliph Omar, remains true to to-day:—

"O Commander of the Faithful, Egypt is a compound of black earth and green plants between a pulverised mountain and a red sand. The distance from Syene to the sea is a month's journey for a horseman. Along the valley descends a river upon which the blessing of the Most High reposeth both in the evening and in the morning, and which rises and falls with the revolutions of the sun and moon. When the annual dispensation of Providence unlocks the springs and fountains that nourish the earth, the Nile rolls his swelling and sounding waters through the realm of Egypt; the fields are overspread by the salutary flood, and the villages communicate with each other in their painted barks. The retreat of the inundation deposits a fertilising mud for the reception of the various seeds; the crowds of husbandmen who blacken the land may be compared to a swarm of industrious ants, and their native indolence is quickened by the promise of the flowers and fruits of a plentiful increase. Their hope is seldom deceived; but the riches they extract from the wheat, the barley, the rice, the legumes, the fruit trees, and the cattle, are unequally shared between those who labour and those who possess. According to the vicissitudes of the seasons, the face of the country is adorned with a silver wave, a verdant emerald, or the deep yellow of a golden harvest."

I cannot even attempt any exact geographical

description of the boundaries of Egypt. Already science is threatening the Libyan desert on the west; while on the east the Khedive has annexed the Somali and Galla country, and has promised to erect a lighthouse on Cape Guardafin; Gordon Pasha has yet to enlighten us on his return as to how much is to be claimed towards the south. Geologically, I have but little to say; more able writers have described fully the general geological characteristics of Egypt, notably in the French work, published in about 1800 by the French expedition. Suffice it to say that the most remarkable features are comprised in the three distinct strata between Philæ and the northern coast. The first or back bone is the celebrated granite, extending from Philæ through the cataract to Assouan, and of which Mr. Basil Cooper recently spoke as follows:—

"Nearly all the obelisks we know or read of were cut from that ridge of fine granite, very free from flaws and shakes, through which the Nile ploughs its way, nearly under the tropic of Cancer, to form the first cataracts. The ancients called it Syenite, after the place, now Assouan, near which were quarried during thousands of years these monolith needles of flame-coloured stone, which Piny tells us were meant to represent the rays of the sun, and were dedicated to that divinity."

From Assouan to Esneh is the sandstone of which the sphinx avenues, and temples of Thebes are chiefly built. It is said to be easily worked and very durable, at all events in an Egyptian climate. From Esneh northwards is the limestone region, the principal material of the pyramids, and this limestone runs below the delta and crops out again at the sea.

My paper to-night, however, relates more particularly to the commercial aspect of the country, especially as developed at Alexandria, which may be fairly termed the Liverpool of Egypt. It is in fact in the Mediterranean second only to Marseilles in commercial importance. Napoleon is reported to have said that "This city should be the capital of the world," and from its position with India and China on the one side, Europe and Africa on the other, it would seem a fit position for an emporium of trade. Its harbour is the only safe anchorage in that part of the Mediterranean, and is capacious enough to shelter the largest mercantile fleets, possessing, as it does, an area of 1,400 acres. Alexandria has been so often and well described, from the "Description de l'Egypt," published by the French Government in about 1800, to McCoan's recent admirable work, entitled "Egypt as it is," that I will not occupy your time by any impressions of my own, suffice it to say that it is still as Warburton described it, "piebald," half European, half Oriental. Its present prosperity dates pretty much from the time of Mehemet Ali, although 2,000 years ago the old port and city were of importance. A century ago the population of Alexandria was estimated by Savary at about 6,000, probably an under estimate, against 215,000 at present, among which are not less than 50,000 Europeans.

It was supposed at the opening of the Canal that Port Said would, to some extent, rival Alexandria, and take much of the trade from her; such, however, has not proved to be the case, and the older harbour, with its splendid modern works, will probably hold its own, unless bad management of the railways throws the Nile transport into use again, in which case some other shipping port may be used for the export of grain, cotton, &c. I mention this possibility, because it has lately come to my knowledge that, in consequence of an increase in transport rates over the railways, boats have been built recently for the express purpose of carrying produce from up country to Damietta, and thence to Port Said, and that, during the last twelve months, produce to the value of nearly one and a half millions sterling has been sent by that route instead of over the railway, which, but for the enhanced rates, would have carried it to Alexandria.

One has only to look at the Nile on the map to see that it is the natural highway for the transport of the produce of the Nile Valley, containing as it does a broad belt of cultivated and fertile land, stretching irregularly on either bank of the river, and averaging about six miles across. About 80 miles above Cairo is the celebrated valley of the Fayoum, which by a series of canals drawing water from the Nile gives to an area of nearly 700 square miles the appellation of the Garden of Egypt. Here sugar, cotton, corn, beans, dates, are produced in abundance. Following the Nile from Assouan, it is estimated, from improved irrigation, seven million acres are available for tillage between that point and the sea, and that of this quantity five millions are actually under cultivation. In addition to this, Nubia and the Soudan have been estimated by Mr. McCoan—a most competent judge—to add 150,000 square miles of arable soil, so that, with these annexations, and under better government Egypt might, with its beneficent Nile, be again one of the granaries of the world.

Cotton has done much for Egypt and ought to have left still better results to show. Found wild in a garden at Cairo in 1821, Mehemet Ali ordered the seed to be collected and planted; stimulated by the high price offered for the fibre, it was largely cultivated throughout lower Egypt. In 1838, Sea Island cotton was introduced, and although the result was excellent, no care was taken in the selection of the seed, and as the cultivation required rather more care than the native plant, its high character deteriorated after a few years. Want of care in the collection of seed for the next season has been a fatal drawback to maintaining the excellence of Egyptian cotton. A resident, however, writing upon this subject, remarks:—

"All that is wanted is a good price for it, and to enable Egyptian cotton to recover its reputation, measures have now been taken to keep the seeds separate, so that the best class of cotton shall be kept free from mixture with the inferior, and not have its value vitiated. It should be stated that this mixture of the seeds has most likely arisen from carelessness. The first cotton-ginning factories here were erected from Platt's drawings of them as they had been erected in South America. The ginning-room floor was raised some 5 ft. or 6 ft. above the ground level, and formed two longitudinal cellars underneath the gin-room floor, into which the seed dropped during the process of separating the cotton fibre from the seed. Thus, it can be readily understood how, after a cotton-ginner had ginned the cotton of one Sheik and then of another with a different kind of cotton, in a few days the seeds must be all mixed up together in the cellars. This, with the hurry-scurry of receiving the camel-loads of cotton, ginning, weighing

packing, and getting it delivered at the station or into boats out of the way, will readily account for the seed not having received proper attention and separation in times past. Another fruitful cause of mixture of sorts is that after the young plants have sprung up out of the ground, places will be observed quite bare, or places where the young plants look unhealthy; the fellaheen sow these places over again with any seed that may come to hand, for they are thoughtless and careless, and singularly deficient in forethought. But all the more recently erected cotton-ginning factories have been made with the floor only 1 ft. above the ground level, and an alley excavated for the shafting and belts, or they are erected overhead, so that the seed is kept in sight on the gin-room floor, from the floor to the dresser, and through the dresser into the sacks. It is an easier mode of working here, and provides against the mixture of the cotton seeds."

My hearers will remember the discovery of a variety of the cotton plant known as Bamia cotton, from its likeness to a shrub named Bamia, which promised to revolutionise the cotton trade of Egypt. It took up half the space of the ordinary plant, and gave, at least, a triple return. It grew to the height of about 10 feet, with no branches, but thickly studded with pods, hence could be planted much closer than the ordinary cotton. As much as twenty times the ordinary price of cotton seed was paid for Bamia seed, and sanguine people thought that in a few years Egypt would supply the world with cotton. But none of these golden promises have been fulfilled. Neither in quantity nor quality has the new plant met expectation. Indeed, the quality has been so inferior that in some contracts for very good quality cotton "Bamia" is expressly excluded. This failure is largely due to the dishonest cupidity of those who sold the seed; tempted by the high prices, they mixed largely inferior seed, consequently few of the experiments have fairly tested the powers of good Bamia seed, but notwithstanding this, it is evident that Bamia is not destined to work the revolution prophesied, and the extent of the export of Egypt must be limited for some time to come at about one million bales as the maximum that can be reached in good years.

Another matter in connection with the cultivation of Egyptian cotton, considered of sufficient importance by the Committee of Manchester Cotton Spinners to be alluded to in a petition to Lord Derby, was the deterioration of the fibre in consequence of the exhaustion from the soil of the phosphates, and this is not a small matter, because the only fuel the fellaheen have to bake their bread with is composed of animal dung, which is carefully collected by the children, mixed with chopped straw, formed into cakes about 10 in. in diameter, laid out in the sun to dry, and called "gilleh." Why these cakes are preferred to wood or cotton sticks is that, after once being lighted up and got into a state of incandescence, they conserve their heat for a long time, like charcoal, and keep the oven at an uniform temperature, while the relays of cakes, about 9 in. in diameter and half an inch thick, are being baked for the family's week's consumption. Washing day is a very small affair in an Egyptian family, if there is one at all; but baking day is an event, and involves commencing at midnight or in the small hours of the morning to complete the relays of cakes. Cotton sticks are all very well for lighting the fire in the oven at first, but they cannot be used for baking bread—the smoke and pyroligneous acid given off by the burning cotton sticks would spoil the bread. Some Sheiks, utilising their cotton sticks for fuel for their steam boilers, have had the upper part of the flue behind the fire eaten away by the pyroligneous acid given out by the cotton sticks. If the Fellaheen could find or afford some other form of fuel instead of "gilleh," the ground would soon become rich in phosphoric acid, and an immense improvement would soon be the result, if they left their cattle dung on the ground during the grazing season. Every working animal in Egypt requires a course of *berseem* (clover) every year, as during the other part of the year they live on dry food—beans and chopped straw. The season commences in November and continues till March; each animal—horse, buffalo, cow, or donkey—is tethered to a stake, which stake is shifted after the animal has shaved off all the *berseem* within the radius of his tether. Animals are in this manner grazed four times over the same field, and it is four times irrigated; and if the dung were allowed to lie on the ground, ploughed in, and sown over with cotton, which would be a very good rotation of crops, as the cotton is sown in April, we should soon find an improvement in the fibre of the cotton. The guano of pigeons is carefully preserved, but this is used exclusively for the cultivation of water melons, cucumbers, and garden stuff.

A writer I have already quoted from says:—

"There is another mode open to the Egyptians to improve the fibre of their cotton, and the best of all. Why not dig out of the catacombs at Sakkara all the bones of the sacred monkeys, other beasts, birds, and reptiles, grind them up in a pair of edge-stones, and sell it to the Sheiks for their cotton fields. This bone dust, sprinkled on the ground and ploughed in, would immediately supply the cotton plants with the phosphoric acid so necessary to the healthy growth and composition of plants."

I cannot say why not do this? I can only confirm what the writer says, as to the great use the sacred monkeys would be if so applied.

Apart from this, the improvements that have been made in the production of the land, and means of dealing with it, within the last 20 years, are astonishing. Formerly, a little mud-brick, flat-roofed hovel, with a few gins and an agricultural portable engine, did for a cotton-ginning factory; but now we see powerful fixed engines of 30, 40, and 50 horse-power, ginning rooms with some pretence to architecture, well lit and ventilated, with roofs supported by trussed principals, with open louvres on the top to keep up a current of air and carry the dust that comes from the cotton away outside, with tall, well-built chimneys; all showing immense progress and improvement. At the establishment of Messrs. Whitworth Bros., at Mansourah, are about 80 cotton gins, several presses, garbles for cleaning the seed, flax scutching machines, and a large corn mill.

The following statistics very fairly express the advances the country has made, and the commercial changes which have affected it. Taking the 13 years previous to the present Khedive's reign, and comparing it with the 13 subsequent, we find the exports from 1850 to 1862 to be £36,339,543; and from 1863 to 1875, £145,939,736; or an in-

crease of £109,600,193. The imports for the same time show—From 1850 to 1862, £29,641,155; 1863 to 1875, 61,939,736; increase, £32,298,581.

As regards cotton, the most important of the exports, in 1850 Egypt exported 5,445 bales, of about 600 lbs. each; 1862, 13,142; 1863, 214,856; 1875, 475,476; 1876, 650,000. In 1877 the export was larger still, and it is estimated by the best authorities that the annual production can, without at all interfering with the cultivation of other produce, be raised to 1,000,000 bales per annum, increased irrigation only being needed to render many thousand acres of land suitable for the production of cotton that are now lying sterile.

Next in importance to cotton is the wheat, of which the export has increased in a somewhat like ratio, but with less regularity, the annual export varying from 30,000 quarters to 100,000 quarters, in addition to which there is an export of both flour and bran.

Beans also form a considerable item of exports; and while in 1866 the export was 42,527 ardebs, of about five bushels each, in 1871, it rose to 711,840 ardebs, and has varied since from these latter figures to about 500,000 ardebs.

Cotton seed must not be lost sight of, for not only has the export risen from 800,000 ardebs in 1866, to 1,500,000 ten years later; but from the improved methods of cleaning it for crushing purposes, the price rose concomitantly with the increased export from 60 piastres per ardeb to 80 piastres, or even 85 for choice parcels, a rise of 33 to 35 per cent. in value to the producer.

Maize, barley, rice, lentils, dara, peas, and some few other grain, used here for feeding cattle, form collectively important features in the exports of Egypt. Flax and linseed also figure to a lesser extent, while wool give from 500 to 600 bales annually; and hides yield a steady supply of about 7,000 bales. The quantity of dates fluctuate with the season, and vary from 5,000 to 10,000 cases.

Sugar has shown a successful development only to be equalled by some British colonies, such as Natal or Queensland; but whether the cultivation of sugar has resulted in any money benefit to the country is very doubtful. Nevertheless, when an export can be raised in seven years from five millions pounds to 260 millions, the commercial aspect of the interest as regards the producing power of the country can be easily estimated. It is pretty well understood in this country that when a gentleman with grand ideas and plenty of money undertakes farming, especially if he cultivates an article he knows nothing about, that the result is not at all likely to be a commercial success. Such has been the Khedive's experience as a planter, but that with proper and judicious management the sugar estates may return an important revenue to the Daira there cannot be any doubt.

An important industry which, I regret to say, has been neglected, or I may say has been destroyed by the dishonesty and chicanery of certain individuals, has been the cultivation of silk. In 1869, Nubar Pasha, then in England, arranged with Mr. Anketell, who had been experimenting with silk cultivation in Egypt, that he should return and commence planting the mulberry for the Khedive, with the assistance and under the auspices of the Silk Supply Association. Mr. Anketell returned, and wonderful accounts were received in this country of the prolific growth of the mulberry, astonishing specimens of silk were received, and sales of grain were made in Italy, at that time suffering from the silkworm disease. At this stage certain officials put in a request for hacksheesh, and as Mr. Anketell was unfortunately a most stubbornly honest man, who would neither take nor give a bribe, but who reported at an interview with the Khedive the offers that had been made to him, from that time he became a marked man to be got rid of. His plantations of many thousands of young mulberry trees were destroyed, and finally after many years of attempts to show by returns how profitable the cultivation, he retired upon his account being shown in some of the public returns as a loss. From Mr. Anketell's experiments, there can be little doubt but that had the industry been properly worked the Daira might have been receiving an income of a million a year from that industry.

Whatever may be the financial state of Egypt, it is unquestionable that the commercial aspects are encouraging to a high degree; and although Egypt, like all other countries, is suffering from the general commercial depression, added to the evil effects of a bad Nile last year, it is certain that nothing but the most perverse misgovernment can prevent its commercial changes for increase and prosperity. For instance, one is continually finding such paragraphs as this, which is taken from the Alexandria advices of a daily paper:—"A Dutch company has recently obtained from the Khedive the right of draining the lake Mareotis, by which means it is hoped that some 750,000 acres of land may again be brought under cultivation. Should the experiment be successful, it is proposed to plant the land thus regained with vines, for which the district was formerly famous."

Time will permit only a cursory notice of the national debt and financial position, a subject in itself of sufficient importance to demand an entire paper. The recent period, however, at which the debt was commenced, enables one to get a fair idea of how easy, with the assistance of money-lenders on the one side, money-spenders on the other, and dishonesty all round, it is for the ruler of a country to get a debt about him, which soon grows entirely beyond his control, and drags the country along in a weary course of expediency, with the view of avoiding bankruptcy and dishonour, which continually hang threateningly before it.

Starting, then, as recently as 1835, we find Egypt with no public debt of any kind—an income of about £2,600,000 and expenditure of £2,300,000. At the end of 1862, when the present Khedive succeeded his uncle, Said Pasha, the revenue had risen to about £5,000,000, and the expenditure to 4½ millions, but there was a public debt of £3,292,000. Heavy outlays on public works now commenced, and continued more or less until quite recently; and, as regards these works themselves, there is nothing to be said against them. The country has shown that it could have fairly supported the costs, but, concomitant with these, were inaugurated a most vicious system of financing, combined with a reckless extravagance, which has, in a comparatively short time, burdened the country with a

mass of debt, which it is now finding beyond its power to bear. In 1864, a loan for £5,700,000 was placed in England, bearing seven per cent. interest, besides annual sinking fund drawings. In 1866, a further £3,000,000 were obtained; and, in 1868, the loan of £11,890,000 was carried through. This last, although a seven per cent. loan, had to be issued at the price of 75, which, in itself, ought to have been a sufficient caution to the rulers.

Even this the country seemed able to stand, but fresh debts continued constantly being incurred, and Treasury bills, with one or two years to run, were issued at exorbitant discounts, until, in 1873, the attempt was made, by an issue of 32 millions nominal, to take up and consolidate the enormous floating debt, at that time said to amount to 26 millions. The wild, extravagant, dishonest issues of Treasury bills, facilities for the discount of which were pressed upon the Khedive and his corrupt administration, has been the most fatal financing Egypt ever suffered from. It is difficult to say at what ruinous discount these bills were issued, but in second or third hands these were sold in London at 30 per cent. discount, and paid at par.

Mr. Cave, in his report, accounts for the general dishonesty by the precarious tenure of office, from the pashas downward, every office being a tenancy at will. And he says:—"The public servant in Egypt, like the Roman Pro-consul, too often tries to make as much out of his office while it lasts as he can, and the scandal takes place of the retirement in a few years with a large fortune of men whose salary is £40 per month, and who have plundered the Treasury on the one hand, and the peasant on the other."

In stating the loans issued, and the interest they bear, I have given the nominal amounts; but as showing the sort of financing in Egypt, I will again quote Mr. Cave, and show what was the actual amount of each loan received by the Treasury, and the interest which had to be provided to meet the requirements of the loans:—

	Nominal Amount of loan.	Real amount received.	Interest	Charges sinking fund.	Total.
1864..	5,704,200	4,864,063	8·2	4·5	12·7
1866..	3,000,000	2,640,000	8·	18·9	26·9
1866..	11,890,000	7,193,334	11·56	1·68	13·25
1873..	32,000,000	20,740,077	10·8	1·56	12·36
	55,887,000	35,437,474			

Of the last amount Mr. Cave says at least nine millions was paid in those Treasury Bonds, which, being long dated, were paid at 93. Mr. Cave adds, "Materially enhancing the profit accruing to the negociators of the loan."

Even this enormous amount I have mentioned did not include the Daira debt, which had grown by the same facilities of issuing Daira bonds, and but for the purchase of the canal shares by the British Government, suspension of payment of some of the coupons and authorised bonds must have happened, and it is stated upon good authority that before the temporary suspension in 1876 three per cent. per month was paid for the renewal of bonds then falling due. Then came the deadlock and the Goschen-Joubert arrangement. These gentlemen, after much labour, found themselves called upon to deal with a debt of 91 millions, fixed by a decree of the Khedive.

Time permits me to give but very briefly the following heads of the plan as finally settled:—The Short Loan Annuities remain as hitherto, but drawings are to be 80 instead of 100. The bondholders of the 1862, 1868, and 1873 Loans have an option of exchanging their bonds for a Five per Cent. Preference Stock to the amount of seventeen millions, secured, first, on railways and the Alexandria port dues, and, secondly, as a first charge on the general revenue. The balance of these loans is to form part of the unified debt. The floating debt becomes part of the unified debt, and the bonus is reduced from 25 to 10 per cent. The unified debt is reduced in all to £59,000,000, bearing 7 per cent., of which 1 per cent. is to be retained as a sinking fund during the nine years for which the Moukabalah law has still to run. As the sinking fund under the Moukabalah is specially applied to the payment of small loans, the remainder is to be also used as a sinking fund, subject to a provision that, under certain circumstances, a portion may go to the Government, while any future excesses of revenue over a fixed amount are to be further added to the sinking fund. The sinking fund is to be used in buying stock in the public market until the price reaches 75, when drawings are to be substituted. A Controller-General of Revenue and a Controller-General of the Public Debt and Audit were to be appointed, with the fullest powers of control. An English Commissioner to be added to the Commission of the Public Debt, which is made permanent, with a right to remit the revenues paid to it to the Banks of England and France. The special revenues remain pledged to the unified debt, to be paid direct to the Commission.

This arrangement can only be called making the very best of a very bad job, for by no principle of equity could the three short loans be docked of 20 per cent., and the paying-off price placed at 80 instead of 100. But the scheme is like sending the ship of State to sea in a condition to meet with fair winds and smooth water; it is like giving the said ship a chain cable, which while it will hold her comfortably enough in fair weather, will fail to keep her off a lee shore when the storm comes.

The first trouble is the Daira debt, which is not provided for, and which, amounting to about nine millions, under the "Reforme Judiciaire," left the Khedive as proprietor, as well as the estates themselves, amenable to the judgments of the reformed courts. The result, indeed, has occurred that the Khedive has been proceeded against by civil action, and that judgment has been obtained against him for some of these Daira debts.

When Judge Haakman, some eighteen months ago, finding that his sentence against the Government could not be executed, declared that the administration of justice in Egypt had become impossible, and closed his court, it was scarcely thought that the course he took would so soon be justified by the attitude of the highest judicial authority, viz., the Court of Appeal. Nevertheless, so it has been, for that august body, in a manifesto issued a few weeks ago, has distinctly informed the Government that it will no more submit to a state

of things which, whilst injurious to the Government, at the same time compromises irreparably the "Reforme Judiciaire." This document declares that the earnest determination of the Tribunals is to assure the creditors of the State the same protection that the law affords to others. That the above amounts to something more than a mere remonstrance on the part of the judges is shown by the latter portion of the manifesto, in which the Vice-President requests the European judges to communicate the same to their respective Governments. What may be the immediate consequences it is hard to say, though it is difficult to see how it can ultimately terminate in anything less than the total abandonment of the new judicial system. The judges on the one hand cannot with any self-respect stand by and see their declaration treated as waste paper, and the Government on the other, with all the goodwill in the world, is unable to satisfy one-twentieth part of the judgments recorded against it. A deadlock, the responsibility for which must rest with the Khedive and his advisers, is, therefore, inevitable.

Time will not, however, permit me to say more concerning the Daira debt.

It would be possible, could Egypt be managed as India is, that the Goschen-Joubert scheme might have been carried out without much difficulty, for Egypt is good for a revenue of 10 millions, but when the important element of honesty is deficient, and only conspicuous by its absence, it is hardly too much to say that, while the Khedive remains an irresponsible despotic prince, the bondholders may easily sun themselves in a fool's paradise. The following from a recent letter upon this subject will illustrate my meaning:—

"What will be done, or whether anything will be done, to meet the present emergency, it is impossible to say, but anyhow the Khedive's difficulties do not arise from any lack of advisers. Curiously enough, the only individual who does not appear to realise the extent of the crisis at which the country has arrived appears to be the Khedive himself. He is still to be found at the Palace of Abdin, surrounded by every luxury—gay, hospitable, and entertaining as ever. When spoken to on the subject of finance the modern Sardanapalus shrugs his shoulders, says he has had his affairs inquired into by Messrs. Cave, Wilson, Villet, Goschen, and Joubert, that he has adopted their suggestions, and can do no more. Hundreds of his subjects, to say nothing of Europeans, are starving only a few yards from his doors; but nevertheless the construction of three stately palaces between Ghezireh and the Pyramids is being proceeded with as before. Such being the case, it can scarcely be wondered at if his Higness's popularity is not on the increase, or if his creditors refuse to acquiesce in any reduction in the interest stipulated for. The impression everywhere is the same—namely, that the country is rich enough to meet all her engagements, and that any inquiry into the revenue is not merely uncalled for, but simply a pretext for defeating the claims of her creditors."

Much credit is due to Mr. Goschen for the prompt manner he has met the cool request of the Khedive to refer the whole matter to the Sultan. The present income of Egypt being clearly insufficient to meet the requirements, Khedive would get rid of the responsibility and trouble by handing Messrs. Goschen and Joubert over to the Sultan, which would mean financing *de novo*, and throwing over previous arrangements now found inconveniently restrictive. With a bad Nile, the revenue has shown about eight millions instead of ten and a half as was calculated for, but as already stated this was a fair weather calculation, and the bad Nile has only expedited a *dénouement* that was sure to come.

One proposed remedy is at once to reduce the interest on the unified debt to 5 per cent., and put the Khedive's allowance at four millions instead of four and a half, but while this can only be tolerated upon the plea of expediency, it educates an irresponsible governor in the facile course of repudiation, *facilis descensus*, and the Khedive has already learnt a good deal of the lesson. For one solution of the difficulty I refer you to the correspondent of the *Times* in Paris, who says:—

"The question of the occupation of Egypt by England has been, since the commencement of the Eastern crisis, one of those which, so to speak, float in the air, of which everybody has a presentiment, and which nobody openly broaches. This subject, which hitherto has been a matter of confidential surmises and mysterious rumours, I now find discussed everywhere, but I was much struck by what I heard from a very enlightened and patriotic French statesman, whose opinions have already often surprised me by their practical character. 'We know perfectly well,' he said to me, 'that sooner or later England, if she does not wish to expose herself to the charge of greatest imprudence, must take Egypt into her exclusive custody. We know that it is impossible for her to confide to any one the protection of practically her sole route to India. We cannot think that she would leave the protection and security of that route to Egypt, who is protected by Turkey, who, in turn, will be protected by Russia; we can be under no illusion, therefore, on this head. Well, our conviction being that the thing is unavoidable, that England must take measures for the security of her highway to India, the sooner it happens the better for everybody, ourselves included. We have no real interests in Egypt, it is true; but we have prejudices which are sometimes more obstinate than interests. On the other hand, we know that England must act promptly, unless she wishes to encounter greater difficulties. Well, not only do I think it would not prejudice the Franco-English understanding, but I believe it will make that understanding, not more probable, but more possible, and thereby give us an additional chance of peace with our neighbours. As soon as France thinks she sees in England a Power desirous of Egypt, she will suspect her, and believe her own interests threatened and betrayed, for there are people who even said we were betrayed when England bought the Khedive's shares; but when once they see Egypt taken and better governed, the lands of which the Viceroy so criminally despoiled them restored to the fellahs, Abyssinia protected against impotent ambition, and Egypt an honest country, France will be the first to rejoice at so fortunate a transformation, the first to profit by it, and the first to see that henceforth there is such a community of interests between her and England that their alliance will become more indispensable. This is why I wish the thing to be done, and that speedily. It is said, indeed, that Germany will thereupon seize on I know not what; but everybody knows very well that if Germany has a mind for anything she will take it whether England occupies Egypt or not. Some people, it is said, wish Egypt to become independent; but I hope this will not happen, for the Oriental who would remain at the head of an independent Egypt would irremediably embroil England and France, in order to profit by their discord.' These reflections would shortly in all probability be those of all Frenchmen if confronted by an accomplished fact."

I believe, myself, a joint protectorate by the two nations of Egypt as an independent country would be better than any occupation by England alone. Neither do I think a recent suggestion of Mr. Brassey in the *Times*, viz., that France should take the Nile and adjacent country, and England the canal and its adjoining lands, under their respective charges, a proper course, for the reason that many of our countrymen have already a large interest both in the land and produce of the Nile districts. For example, at the establishment of Messrs. Whitworth Bros., at Mansourah, the concrete bund or sea-wall alone cost £3,000; and, as will be seen by the photographs before you, this quay forms but a small portion of the capital invested there.

Not all the might of England can preserve the canal, if it comes to fighting about it. It is vulnerable in its whole length. One blast of dynamite would do more mischief than could be restored in a week, and one sunken ship blocks the canal. One camel starting from Cairo would be sufficient to carry sufficient material to reduce the canal to a temporary wreck. Of course, the same peaceful arts that made the canal could restore it, but I would warn my hearers against supposing that any Power can preserve the canal intact against an active, energetic foe, bent upon its temporary destruction. Anyone who has passed through the canal in one of our long merchant steamers must have been struck with the great care necessary to prevent that steamer taking the ground and accidentally blocking the canal, the necessity for working the canal in sections, and of carefully shunting one steamer at the end of a section before permitting another to be signalled on from another section. You have only to imagine a steamer under a neutral flag permitted to enter, and then wilfully sunk in the middle of a section, to have an effect produced equal, in a military point of view, to the destruction of the canal.

Our protectorate must not be limited to the canal, for it may happen again, as it did during the Indian mutiny, that we require the railways to send troops out to India. Without going into details, I will simply express my conviction that Egypt, as a colony of England, would, for some time to come, be a political mistake.

To sum up, we find in Egypt a country fertile and prolific from periods that date back to a hoary antiquity, that has continued from time to time to maintain its reputation according to the ruling Governments, and that has shown such signs of commercial vitality during the last few years as place its commercial aspects more on a par with a prosperous young colony of Great Britain than one of the oldest countries the world has record of. Whatever may be the future fate of Egypt, bad management by bad Governments can alone stay progressive prosperity from passing over the land. As for the Khedive, whatever else may be thought or said of him, there is one act of his reign, or vice-royalty, which will for ever stand a bright epoch in the history of his life; namely, that which he performed when he abolished slavery in his dominions.

DISCUSSION.

Mr. Hale thought the evils under which Egypt suffered arose from the defects of its rulers, and hoped that Englishmen would in future decline to put any money into foreign loans.

Mr. Jones said he had lately heard an anecdote of a pasha, which illustrated the mode in which appointments were made. Directly on his appointment he invited one of his officers to a magnificent repast, but had given his servants orders to take his visitor before he left into a separate chamber and give him the bastinado, so that he might know there was full authority in his chieftain's hands to secure obedience. This illustrated very well the fact which had been stated of the necessity for each officer to make as much as he could, and as quickly as he could.

Mr. Andrew Cassels said he was very sanguine as to the future of Egypt, which he considered was really the land of promise. He felt satisfied that under honest and able management, and a really good scientific administration, the country was fully able to bear all the burdens it had to carry. When one thought of the discoveries recently made in Africa, and the way in which the country was opening up, one could not but see that there was a great future for Egypt. The soil was wonderfully fertile, and as Douglas Jerrold said many years ago, "When you tickled it with a harrow it laughed with a harvest." The climate was beautiful, and you could grow almost anything there, and within the last few years a most astonishing increase of exports had taken place; so that whatever the present difficulties were, they would in time disappear. Without at all holding that England was to assume the custody of Egypt, he thought that by degrees we should exercise a certain control over it; and that when talented Englishmen one after another went out to take part in the administration of the country, an improvement in the revenue would be seen. As to the canal, it was quite true, as Mr. Cobb had said, that it might easily be closed, but if it were, we should not be ruined in India. Our troops and merchandise could do still as they did before it was opened, so that the question was not all important. In conclusion, he would only repeat that with all the troubles which at present were weighing upon Egypt, there was a great future before it.

Mr. Anderson concurred with the last speaker that there was a great future in prospect for Egypt.

The Chairman said he must remark at the outset that the title of the paper had scarcely led him to expect that he should have to listen to a discourse imputing so much blame to the ruler of Egypt. He had had the honour of knowing the Khedive for many years, and though they did not hear much to his credit in this country, there were always two sides to a question and to a character. Though he was far from approving entirely of his conduct and administration, there was a great deal to be said in mitigation of many of the charges which were brought against him. He came to the throne some 13 or 14 years ago an inexperienced person, and became the victim, the repeated victim, of persons who furnished him with money in abundance at high rates of interest, and in a manner which was very seductive to one who, like him, was totally ignorant of financial matters. He undertook the abolition of what was called forced labour, in connection with the canal, and in consequence he might state, without fear of contradiction, that the Egyptian debt had been increased by about 18 millions. The canal, instead of being an advantage to Egypt, had been a terrible loss. The commerce which used to pass across the Isthmus now went by the canal. There was a large harbour constructed at Suez and another at Alexandria, and the commerce could have been accommodated there and by the railway. At the same time, in the interests of England and the whole world, the canal was a great blessing, though it had been a misfortune for Egypt. As to the prospect of the canal being disturbed, there was a great deal in what Mr. Cassels had

said, that mischievous persons might readily blow up a ship with a torpedo in the middle of the canal, and, therefore, he thought England ought to have charge of the whole length of it, by arrangement with the Egyptian Government. The ends could easily be guarded by ships of war, but its whole course ought to be under English protection by means of Egyptian troops, because it was easily open to attack from Syria. He could not exactly define at the moment how it was to be done, but in the interests of Great Britain and of India he thought the entire protection and control of the communication should be in the hands of England. As to the mode of effectually guarding the canal, there was the harbour of Alexandria, with an area of 1,500 acres, which was now enclosed by a large breakwater; and if only the entrance were improved, the whole navy could lie there in safety in deep water. It would require some little outlay, because at present the depth at the entrance was only 25 ft.; but this ought to be done; and some of our ships should be always stationed there, as well as at Malta. With regard to the development of Egypt, it must be remembered that the population was not more than five millions, and however fertile a country might be, you could not feed the whole world with the labour of five millions. The population did not increase rapidly, not that there were not plenty of children, but great numbers died under five years of age. He had made himself fairly acquainted with the country, having gone there annually for the last 12 years, and having visited every manufactory and large engineering work. The whole secret of production lay in irrigation, and if water could be supplied much more produce would result. At the same time it was not quite correct to say that Egypt would yield an immense quantity of wheat, beans, and so on, because one acre of land in England yielded a better crop than the average of the whole of Egypt; the difference was that in Egypt the cost of production was not more than one fourth; its wealth lay not in excessive production, but in low cost; and that was one of the things which enabled a smaller population to do a larger amount of cultivation. Great things had been done in the way of irrigation. Mr. Cobb did not explain how it was that far more water ran into the sea at Damietta and Rosetta than passed the cataracts, and he could not believe that such was really the case; because the Nile, oddly enough, had no tributaries for over a thousand miles, and one would naturally suppose that it would grow smaller by evaporation and continual irrigation from it. With no rain and no tributaries, therefore, the outflow must be less, and he believed it was less, and he had seen it at both places. When he was in Cairo he was visited by Gen. Vivian and Gen. Grant, the ex-President of the United States, and in speaking of the Nile the latter said he had been informed by Mr. Stanley that it was eight times the volume at its junction with the White Nile that it was at Cairo. He said he did not see how that could be, for he could hardly think that seven-eighths of it was taken off by evaporation and irrigation. The fact was Gen. Grant had mistaken what Mr. Stanley had said, for only a short time before, in talking with him on the same subject, he had said the river Congo was eight times the volume of the Nile. This no doubt led to the mistake, and he thought Mr. Cobb must have fallen into some similar error. For some 200 miles above Cairo, 15,000 to 20,000 men were employed in raising the water, and engines of 200 or 300 horse-power were used for the same purpose. To get rid of this enormous expense, the Egyptian Government had constructed an irrigation canal. The river fell at the rate of about seven inches per mile, and the land followed exactly the same slope, and was as level as if it had been planed with a planing machine. A large canal was commenced at Hassel, which was only allowed to fall about three or four inches per mile, so that by the time it had got some 25 miles down, the water was up above the land, and would flow over it without any pumping or lifting. This canal was about 200 miles long, and the water was constantly led from it to irrigate the ground on each side. A great portion of the land thus supplied belonged to the Daira or private estate of the Viceroy, on which he had borrowed money; and there was some trouble in its administration; and no doubt he spent large sums in an extravagant way. Looking at the prospects of Egypt, he had a strong faith in its future, believing that its natural resources were very great. There was a beautiful sun, a beautiful soil, and beautiful water, the finest in the world; any one who had once washed in it always wanted to get back to it again. He did not think that those who had money in Egpyt need be alarmed. He had a great deal there, and did not shed tears over it; for, though he did not suppose he could get it all immediately, he believed it would come right in the future. The great fault of the Khedive was that he wanted to do everything at once. One thing he wanted to do was to erect a *barrage*—a large barrier at the top of the delta where the Rosetta and Damietta branch came from, so as to raise the water 5 ft., by which Mr. Fowler estimated that the value of the land below would be increased by £2,000,000 per annum. That was not his own estimate, but he had no doubt the value would be immensely increased. Speaking generally, the people were docile; they were not Turks, but Mussulmans who were ruled by Turks, and up to this moment were subjects of the Sultan. Whatever the course of events might be—which it was impossible to foresee—he believed the mass of the population looked to the Sultan as the head of their church, and felt a stronger adhesion to his authority than to any other. Nevertheless, if ever it should appear well, in the wisdom of the nations of the world, that England should stretch her arms out to embrace Egypt, he believed the people would not be unwilling to be under English care. He did not say that he desired to see this take place, but he should be very glad to see some understanding between the Khedive and the English Government for the purpose of improving the Egyptian administration, and particularly with the view of guaranteeing and rendering secure our great highway to India. There could be no doubt that by having only one method of communication, we were not so secure as we should be with both.

Mr. Kennelley said that he visited Egypt 28 years ago, when the Suez was merely a collection of mud huts, and railways had not been introduced, and he had also visited it recently and seen the wonderful changes which had taken place. He should like to ask what prospects there were that some of the English capital which had been invested in Egypt would find its way back here. This was a point of great importance, and although he did not wish to enter into the political aspect of the subject, he must say that he saw but little likelihood of England getting back any of this wealth unless Egypt were honestly and properly governed. Very great improvements must take place in the present administration before any satisfactory results could be expected. He should like to ask Mr. Cobb, with reference to Alexandria, whether any attempts were being made to open up the harbour so as to make it available for ships of 30 feet draught of water. When he was there he had experienced the inconvenience arising from the ship being detained outside for some considerable time, and, as in his opinion it was capable of becoming a most magnificent harbour nothing would give him greater pleasure than to hear that something of this kind was on the *tapis*. He should like to ask the Chairman why he considered the canal had not been a blessing to Egypt. He should think that, although it might not have been a blessing to the Khedive's treasury, it certainly had been a very great blessing to the province, because it had been the means of attracting a great amount of European energy and skill, which would not otherwise have been introduced. He hoped that England would do its duty by the canal. It was not only to our interest, but to the interest of

Egypt, the Khedive, and all concerned with that province, that it should be in very intimate relation with home. When the English Government guaranteed the Turkish loan, he believed there was a tribute from Egypt which formed a collateral security, and he should like to know whether this was not in default, and whether the English Government had not paid that money.

The **Chairman**, in reply, said he did not believe that Egypt was in default with her tribute at all, and, as regarded the money that people in this country had lent to her, they had got their 6 or 7 per cent. There were no arrears of interest so far as he was aware of, and the difficulty and the disagreement which had prevailed the last three months arose in this way. The Decree of November, 1876, went on the presumption that Egypt would yield 10½ millions. Certain persons had been appointed to collect the revenue, who were all Europeans, and it was arranged that £4,250,000 should go to the Viceroy for his expenses, and £6,000,000 be paid to the English and French creditors. When he was there, the £6,000,000 had been fully paid and sent out of the country, but the Viceroy had only £1,700,000 left, and all his people were loudly clamouring because they could not get their wages and salaries. If the canal had cost the Khedive 18 millions, and brought him no gain, it could scarcely be called a blessing; especially as it had actually been the means of withdrawing £200,000 of traffic a year between Suez and Alexandria. Besides having lost his traffic on the railways, it must be remembered that the Khedive had now no shares in the canal. The harbour at Alexandria was completed inside, but proper access to it had not yet been made. The question was whether this was to be done by Egypt or by those who wanted to go there, that is, the Egyptians thought if we wanted our big ships of war to enter, we had better blow up the rocks ourselves.

Mr. Cobb, in reply, said, with reference to the completion of the harbour at Alexandria, it was only a question of money; if that could be procured, the works would be completed. He could confirm the Chairman's remarks with reference to the guaranteeing of the Turkish debt, that the Egyptian tribute was not in default. It had been stated that one of the faults of the Khedive was attempting to do everything at once, but in a country like Egypt, where there were improvements to be made on every side, this was calculated to cause the greatest confusion. With reference to the Chairman's remark that he had not expected to hear the Khedive blamed, he (Mr. Cobb) had stated particularly in his paper that, as regarded the public works, there was nothing whatever to be said against him, although he had conducted them in such a way as would not be tolerated in England. A sample of the Khedive's sugar looked almost like Finzel's crystal, but if he had contented himself with making a common sugar, without going into the scientific processes, he would have made much more profit. The Chairman had alluded to the wealth of Egypt in relation to the cost of reproduction, and the population of the country. He had not referred to those points in his paper, because time would not permit, or he would have been glad to make some remarks, especially with reference to the Coptic race, who are said to be Christians. For the same reason he had not referred to the railways, and had only referred to the canal from the political point of view. He had not been able to touch upon much relating to the produce of Egypt, as it would have gone far beyond the limits of one paper to deal fully with all these points. The Chairman had stated that the Unified Debt was not in arrear, but the payment had only been postponed three months, and some people considered that as being in arrear, while others, perhaps, did not. With regard to the amount of water passing out at the Damietta and Rosetta branches, he mentioned it as one of those problems which he could not go into; but there was the high authority of the French Expedition of 1800 for what he had stated, and it was confirmed by other authorities in recent works which could be referred to. His only object in touching on the geology of Egypt was to refer to the limestone, which, as he had mentioned, was a great water carrier. It extended from the cataract at Philæ to a little beyond the sandstone, and then the limestone was lost under the Delta, disappearing at Cairo, until you met with it again outside Alexandria in the shape of those rocks which it was now desired to blow up. The theory was, that limestone being a great water-carrier, held more water than was suspected, which found an exit in the channel of the Nile, and when he said that science was threatening the Libyan Desert it was that which he had in view. Those oases, which were found in some parts, were simply depressions in the sand, like a saucer sunk in it, and there water was to be found, and vegetation was met with. This question of the output of the Nile was connected with the limestone and with the oases also. Mr. Cassels had confirmed his view that, except from the most wretched misgovernment, nothing could prevent the progressive prosperity of Egypt. Personally, he did not wish to speak against the Khedive, but to condemn the wretched system of finance, and the way in which money was squandered which never gave a penny of profit to Egypt or the Egyptians. It was a vicious system of obtaining money for the present moment at any price, in fact, the Monkabalah loan was just a *post obit* and nothing else.

On the motion of **Dr. Mann**, a vote of thanks was unanimously passed to Mr. Cobb for his valuable paper.

FIFTEENTH ORDINARY MEETING.

Wednesday, March 20th, 1878; F. J. Bramwell, F.R.S., Member of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Bardsley, Joshua, F.C.S., Church-hall, Church, Lancashire.
Bird, W. S., 36, Rathbone-place, W.
Bland, T. F., Stourbridge.
Davis, Walter Charles Hart, Westbury-park, Durdham-down, Bristol.
Nixon, John, Home-office, Whitehall, S.W.

The following candidates were balloted for and duly elected members of the Society:—

Barker, Stephen, Calthorpe Fields, Edgbaston, Birmingham.
Coles, Oakley, 5, Upper Wimpole-street, W.
Hadland, Miss S., Milton-mount College, Milton-on-Thames, Kent.
Kennedy, E., M.D., 24, Queensberry-place, S.W., and Belgard-castle, Clondalkin, Dublin.
Lee, William, Summerfield, Prestwich, Manchester.
Lo Fong Loh, C.I.C.S., 7, Weymouth-street, Portland-place, W.
Patteson, Henry, 6, Anson-road, Victoria-park, Manchester.

The paper read was—

EMERY AND CORUNDUM WHEELS FOR GRINDING AND SURFACING METALS AND OTHER MATERIALS.

By Arthur H. Bateman, F.C.S.

The two great divisions of the metal industry are the elimination of metals from their ores, and their working up into forms for use.

The first class involves highly scientific processes, chiefly carried out by unskilled hands, the second necessitates individual skill on the part of the workers.

The chief means of working up metals are, casting, forging, and shaping, both of the former requiring more or less of the latter, and in each the removal of superfluous metal plays an important part. This is effected chiefly by files and chisels, to some extent and in some branches also by grindstones.

A file is a specially prepared tool, of which only a very small per-centage can be considered to be practically useful. A chisel is the same, and requires constant attention to its small cutting edge, the great bulk of its weight also being useless for its actual work. A grindstone, reduced to its elements, is composed of a large number of particles of natural material, mostly silica or its combinations, and the individual grains of which are irregular in hardness, shape, and size, mostly smooth and comparatively rounded. It will attack hard metals, which the file and chisel will not, but, owing to the difficulty of securing real homogeneity, it cannot with safety be run at the speed requisite to utilise its full cutting power.

For rapid working of hard materials, whether metals or stone, &c., something harder and more lasting than these tools is required, and for many centuries natural substances have been used to assist.

It is probable many of the ancient gems now in existence were cut by the help of emery powder, and to this day the Indian and Turkish lapidaries use a wheel compounded of shellac and this material, rotated with a drill bow. This remarkable substance is often spoken of as steel filings, or as an oxide of iron, but it is really a mixture of corundum and oxide of iron. Corundum itself is almost pure alumina with a little silica, and, in its purest form of all, slightly tinged with iron oxides, is sapphire and ruby; in a less pure state, and with traces of various foreign substances, it is of commercial rather than fancy value, and is found in unimportant quantities in various parts of the world. It is also known as adamantine spar. Comparatively recently large deposits of corundum were ascertained to exist in America, and it is a somewhat singular fact that this took place almost simultaneously with the discovery, in 1847, by Dr. Lawrence Smith, an American geologist, of the now famous Turkish deposits of emery. The former, however, was allowed to lie dormant until 1865, while the latter, being brought to the notice of the Government, were almost immediately utilised. Further investigation showed these deposits to be of considerable magnitude; the chief are near Smyrna and the ruins of Ephesus, also in several islands of the Greek Archipelago, notably Naxos, from a promontory in which island—Cape Emeri—it takes its name. Deposits of little or no commercial importance are also to be found in Jersey, Spain, Poland, Saxony, Sweden, Persia, and the Andes of South America. Quite recently, it is stated, important discoveries of emery in a granular form have been made at the Adirondacks in the North American Continent.

Although called mines, the emery workings are really on the surface only, or very little below the surface. The dark red colour of the ground affords a pretty sure indication of its presence, but steel rods are struck into the earth, and a practised eye soon detects the presence of emery rock by the markings on their points. The mineral occurs chiefly in large masses, sometimes susceptible of rough breaking, at others resisting blows. In such case, a fire is lighted round the refractory lumps, and on cooling after some hours of heat they will often be found more amenable to treatment. Blasting is seldom practicable, from the difficulty of drilling holes. As transport to the sea is solely attainable on the backs of mules and camels, a weight of about 100 lbs. is considered the practical limit for individual lumps. The Turkish and Greek Governments sell the monopoly of raising emery rock, and for many years nearly the whole has been controlled by English capitalists, in fact, until recently, a company known as the Levant Company have had the practical control of the market. During the last few years there has been more independent working, and the supplies have been large, but at the same time, a greatly increased quantity of inferior rock has come to England. It is chiefly sent over as ballast; freight thus is an insignificant item.

The specific gravity of emery ranges from 3·75 to 4·28, and may be taken to average 4·0, the colour varies from dark grey to black, and is no indication of value. Owing, however, to general misappreciation of this fact, some English firms colour their crushed emery to a uniform tint, and uncoloured emery is often unsaleable, and put down as bad or impure by buyers used to a particular shade.

Nothing is done in the producing country beyond the rough sorting and breaking into lumps under the above limit of weight. On arrival in this country the emery crushers submit it to treatment, to render it available in manufacturing processes. There are but few firms in this trade—until within a few years since only four or five, but at present more are engaged in it. As a rule, emery crushing works are not shown in operation. Several processes are employed, each being held to possess its own special advantages. First, the rock is crushed into pieces about the size of walnuts, by passing again and again through Blake's or other crushing machines; it is then either stamped with stampers, passed between chilled rolls, or through grinding mills, the latter being circular cast-iron plates with upright lands six or eight inches high. These wear away by degrees as may readily be believed, but last from four to six weeks. The jaws of the crushers last from two to three weeks, stamps last longer but work slower; of the life of the chilled rolls I have no information. Microscopic examination of crushed emery shows, not only the distinct presence of the two substances, corundum and oxide of iron with a certain per-centage of quartz which is often mixed with the emery rock, and a trace of iron from the machines, but also in many instances iron slag and other similar substances used as adulterants. It is by no means certain that some such substances may not be a positive improvement in some respects, as causing a freer cut; but in this case it is certainly desirable that any such admixture be made by the user and not by the crusher. All makers of solid emery wheels guarantee that they use pure emery, but as only one firm crushes its own rock, the

microscope should always be used to see that what is bought as pure emery really deserves that name. The microscope also shows that there is little, if anything, to choose between the grains produced by rolling, crushing, stamping, or milling, as far as regards sharpness of angle. The great points seem to be attention to quality of rock, careful removal of bad pieces containing foreign matter, and accurate sifting.

By the kindness of Messrs. Acton and Borman, who have large emery crushing mills, I am enabled to show a very good selection of emery rock, good, indifferent, and bad.

After the emery has passed through the machines, it is sifted through a series of sieves, ranging from 6 to 100 linear meshes to the inch, and all pieces larger than the former size are returned to the machines for further crushing. The process is an eminently dusty and disagreeable one, and from the beams, roof, and upper parts of the crushing shops is collected what is known as flour emery, which has deposited from the atmosphere. Finenesses of 120 and even 140 are thus obtained. Still finer grades are, however, required for polishing plate glass, opticians' work, &c., and for this the very beautiful process of elutriation or washing over is employed. A dozen or more metal cylinders, three or four feet high, and ranging from three inches to 36 or 40 inches diameter, are connected near their upper edges by pipes; the whole series is filled to the brim with water, emery and water well mixed are introduced into the smallest vessel; the water of course flows out at the opposite pipe to the next, and so on through the whole series. The coarsest powder falls during its three inch journey across the first cylinder, the next coarsest through its four inch, then its six inch, and so on, until at last practically pure water flows from the exit tube of the last 40 inch vessel. After a time the process is stopped, the material allowed to subside, the superincumbent water decanted off, and the deposited emery removed and dried. This process is carried out by the users, not by the crushers.

The chief use to which powdered emery has been put is, in its raw state, in metal workshops, also for glueing on to sticks of the shape of files, for use with lead laps or polishing wheels, and glued to paper or cloth, in which form it is generally used by mechanics, wrapped round a stick or flat piece of wood. Paper seems better for this purpose than cloth, though the latter is preferable where it is used without such support. Envelopes of emery paper with shaped sticks have also been patented, but have never come into general use. Emery has also long been extensively used for buffing and polishing by covering a wooden disc with leather, glueing fine emery on to the surface, and rotating it when dry at a high speed. The yielding nature of the latter causes this to be absolutely unsurpassed as a polishing medium for hard metals or other substances.

In 1842, Henry Barclay patented a process for a solid emery wheel, using an equal part of Stourbridge clay and emery, pressing the wet mixture into moulds, and subjecting it to a bright red heat. This is said to have given a really efficient wheel, but it does not appear to have been practically worked, as only small discs, say eight or nine inches diameter, could be made, owing to the difficulty of avoiding cracks and distortion in the process of firing. It is satisfactory to know that the actual father of the modern emery wheel was an Englishman, although the development of the idea has certainly taken place on the other side of the Atlantic, and we are now appearing to be copying our American cousins in our tardy adoption of a *bonâ fide* English invention. About ten years later, I believe, efforts were made to introduce and extend the use of solid emery wheels by Mr. (now Dr.) Anderson, then of Woolwich Arsenal, but it has only been during the last five or six years that anything approaching to general attention has been paid to the subject.

Five years ago, there were many makers of solid emery wheels in America, but only about four in England; at the present moment there are double this number, and one of the leading American makes is personally represented in this country. Notwithstanding the depressed condition of the metal trade, the sales of most of these makes have probably something like doubled annually of late, showing that the subject is one assuming real commercial as well as scientific importance, and worthy of the attention of the members of this Society.

An important peculiarity of emery or corundum is its extreme hardness. The diamond is the hardest substance in nature; absolutely pure corundum, in the form of sapphire and ruby comes next; the commercial variety is scarcely inferior, and closely approaching is emery; but a still more important feature of the latter substance is its tendency to break with a rough surface, or what is known as conchoidal fracture. However finely the rock may be crushed, this roughness still exists, and even flour emery, examined under a moderately high power is found to sustain this peculiarity, and to present a series of sharp angles and points. As an individual grain wears smoother by friction, it still, to a great extent, carries out this disposition, so that a disc or wheel made of grains of emery, if properly cemented together with a binding material that will not melt and form a skin on the cutting surface (as is sometimes the case), presents absolutely a constant succession of fresh cutting surfaces.

The question has been asked, whether a disc of solid emery rock would not be better than crushed grains cemented together again. The answer is obvious, that the vast amount of rough surface present in the built-up wheel would be absent in the solid mass, quite apart from the extreme difficulty of manufacture.

The peculiar property of conchoidal fracture above referred to, as possessed by emery, is not shared in anything like an equal degree by corundum, and although in crushing this latter mineral many sharp points are obtained, there are also considerable plain and curved surfaces, never seen in the somewhat less hard emery. The result is as might be anticipated—the process of manufacture being the same, a disc of corundum will, under similar conditions of running, do as much or perhaps more work than a similar disc of emery, but it will heat the metal much more, because, while emery with its sharp points cuts its way, corundum with its harder but smoother faces tears its way into the work. For certain purposes, where it is possible to run in a constant stream of water, corundum wheels appear superior to emery; but for

the general run of engineers' work, which is certainly on the whole done best dry, for tool grinding, and indeed most other purposes, our English experience is so far vastly in favour of emery over corundum wheels. A common form of corundum is that known as "ruby," this is found in small grains averaging about 24 grade. It is waterworn and rounded, and breaks with comparatively smooth faces. This material, crushed, however, makes very good fine wheels.

The natural corundum of North America, which is much rougher in grain, has been specially worked up by Messrs. Morton, Poole, and Co., of Wilmington, Delaware, with the special object of trueing chilled rolls. I am not aware of the process used, but am informed that extremely good results have been obtained. This same operation is, however, conducted in Belgium, Germany, and elsewhere, with emery wheels, with entire success.

The microscopic projection on the screen of actual grains of emery and corundum clearly shows the peculiarities of the respective substances, and to emphasise the distinctive characteristics of numerous small points *versus* larger points and wide planes. I add projections of sands, crushed grindstone, flint, and glass. You will observe at once that the sharp points of the latter substances must give good work until broken off, when the cutting power will vanish. You will also note the smooth and round appearance of the grains constituting the ordinary grindstone.

These projections indicate the probable relative cutting power of the various grains available for the manufacture of grinding wheels. It now remains to consider the best means of agglomerating these grains into a solid mass and utilising the same.

It is manifest that, by the adoption of the circular form, steam power may be used instead of manual labour, and if a cement of sufficient strength be employed to withstand the centrifugal force (which increases as the square of the velocity), we have the remarkable result of, on the one hand a steel file moving at the rate of about 60 feet per minute, driven by a man whose arms grow tired, and the tool itself useless when under 5 per cent. of its weight is used up, and on the other a circular file much harder than steel, whose cutting face never grows dull, driven by a steam-engine which never gets tired, at a speed of 5,000 feet per minute, and which can be used up to the extent of about 90 per cent. of its original weight. Small wonder, therefore, is it, that rapidity, economy, and precision are obtained by this new tool, and that it has shown rapid growth, since it first obtained a footing in English workshops.

Circular steel files (of which a specimen is on the table) have been tried more than once, run on a lathe or other rotating spindle, but their high cost, and the difficulty of preserving a flat face during the hardening process, and the small percentage of useful material, combined to prevent them coming into general use.

It may be asked if one half of what is claimed for the solid emery wheel be true, how is it that, instead of a gradual introduction, it does not instantly take its place in every workshop in the kingdom?

The answer is fourfold. 1st, the English working man (and to a certain extent the master also) is intensely Conservative—why should he now use a tool he has done without all his life? 2nd. It is said we cannot be perpetually adopting American "notions"—forgetting this is really an English notion adopted by the Americans because they have found it to be a real economy, which enables them to positively compete with us in our own markets, in the face of the heavy charge for 3,000 miles of carriage. 3rd. It has already been tried and found a failure—probably put to unsuitable work, something that could not be done any other way, and an expectation formed that the new tool could be used in a moment without practice, condemnation following, because immediate success was not obtained. 4th. A dread, or fancied dread, of the necessary speed—quite oblivious of the fact that our trains run faster, our circular saws run faster, our wood working machines run faster, and that with the proper and ordinary precautions requisite in all high speed machinery, there is no more danger than with many tools in everyday use already.

The novelty of emery wheels has caused the few accidents that have happened to be noised abroad, while those occurring with grindstones excite little attention. After considerable research, I am unable to obtain actual figures on this subject, but there is little doubt in the minds of those qualified to judge that the per-centage (not the actual number) of emery wheel and grindstone accidents, is much in the same ratio as those of railway trains as compared with stage coaches.

It may again be asked, have any firms of repute, after introducing emery wheels, discontinued their use? In some few cases this has been the case, the reason given being that the opposition of the workmen did more harm than the use of the wheels did good; but coupled with the avowed intention to try again later on. On the other hand, the firms who have extended their use of this labour-saving invention, after their first trial, are large in number and an ever increasing quantity. In many shops grindstones have vanished; in others the file bills have been cut down to one-half and one-third; in others, again, work heretofore impossible has been successfully accomplished, and materials hitherto unavailable have become admissible. A file can cut nothing harder than itself, and hard steel and chilled cast iron defy it. These materials are readily amenable to the solid emery wheels, and a new art has sprung up with their introduction, that of shaping dead hard metal either flat or cylindrical, instead of turning and subsequently hardening, the latter process not infrequently resulting in the destruction of accuracy by twisting and warping. Specimens of such work are on the table.

To the manufacture of a good solid emery wheel three essentials combine—good emery, good cementing materials, and extreme care in their combination. Probably the earliest commercially successful solid English emery wheel was that introduced 16 years ago, under the patents of Coles, Jacques, and Fanshawe, in which the cementing material is that curious compound known as oxydised oil, largely used in the well-known linoleum. The cement and emery are intimately admixed, pressed into accurate metal moulds, and subjected to a high temperature under the action of superheated steam. The resulting wheel is re-

markably strong and homogeneous, is susceptible of manufacture in very thin discs, being to a certain extent flexible, and although giving off some slight smell in use, is widely accepted as a very valuable wheel. Another form is manufactured with shellac as its binding material, the ordinary smell of this substance being almost overcome by a peculiar mode of manufacture not made public. This process can be applied also to covering light iron pulleys, rims, and plates of metal, and is said to give good results.

A recent introduction to this country is the manufacture of what is known as the Union wheel in America, but is here called the Magnesian, from the fact of the cementing substances being oxychloride of magnesium. A positive stone is the result, for which enormous inherent strength is claimed, while a low rate of speed is, nevertheless, recommended as the best for cutting. Yet another process is that of Mr. F. Ransome, in which silicate of soda (dissolved flint) being mixed with the emery grains, together with a small proportion of free lime and a natural soluble silica, double chemical decomposition is set up, resulting in the almost entire change of the three cementing substances into the one insoluble silicate of lime, which binds the emery in enormously strong bonds, the action being facilitated and hastened by the application of gentle heat, not baking as is sometimes erroneously stated. A remarkably strong and free cutting wheel is the result. Being hard and unyielding, thin discs require considerable care in use, but the inherent strength of the material is enormous, and when sand is used as the base instead of emery a most successful building stone is produced.

Two or three other processes are also used in England, but are not made public. Samples of the wheels referred to are on the table with portions of the majority showing the internal structure of the finished wheels.

On the European continent, besides imported wheels, there are several local makes of varying degrees of merit, but mostly cheap (or rather low-priced), and with greatly less cutting power than English and American wheels.

In America, the natural home, at present, of the solid emery wheel, the processes are numerous and the sales very large. The Tanite, now represented in England, has long enjoyed the reputation of being the standard wheel; it is the highest priced; the cementing material is believed to be a solution of leather. The Union wheel (called Magnesian in England) took the Philadelphia Exhibition medal in 1876, and now claims to be the leading American wheel; it is sold in England under the auspices of a highly respectable London firm. Others may also be named: the Northampton, enjoying a good reputation; the Vulcanite, calling itself the genuine and original; the Climax, claiming to be made of American emery recently discovered in the Adirondacks, and to dispose of a cubic inch of cast iron in 49 seconds; the Vitrified, a porous wheel with a central water supply; the Cosmopolitan, and many more. Each of these wheels—or rather their makers—claim to be positively the best, some advocating high, others low speed, and generally indulging in those little amenities at the expense of their rivals, fortunately more common across the water than with us.

Turning now to the uses of emery wheels, both actual and prospective, I have obtained particulars of the uses to which they are put at the present moment in this country, and submit the following list, which, however, probably by no means exhausts the subject:—

1. Fettling castings, steel, all kinds of iron, brass, and gun metal.
2. Grinding cranks and crank pins in hard, chilled, and case-hardened iron.
3. Surfacing locomotive slide bars.
4. Trueing case-hardened and chilled rolls.
5. Bushes for axles; brazed joints of tubes.
6. Clearing grooves of oilcake chilled press plates.
7. Drums and pulleys, either entire, or for starting the skin to allow lathe tool to enter.
8. Finishing forged connecting rods, pistons, glands, valves, bolts, and nuts.
9. Cleaning wheel teeth.
10. Saw sharpening and gulleting.
11. Plough shares and reaper knives.
12. Work for galvanising.
13. Tips and heels for boots.
14. Long cutting knives—paper, leather, tobacco.
15. Iron and brass stove and fender work.
16. Iron and brass taps, cocks, and valves.
17. Sewing machines, including spindles.
18. Slides for rests, beds, mortising machines, &c.
19. Cards on cylinders of carding engines.
20. Shuttle tips.
21. Spades, shovels, forks, &c.
22. Cast-iron railings.
23. Grinding "doctors" for print works.
24. Tool grinding and sharpening.
25. Twist and other drill sharpening.
26. Hard steel magnets.
27. Gauges for fine work to 1-1,000 of an inch.
28. Mowing machine knives.
29. Fitting keys, &c.
30. Ends of shafting.
31. Lathe centre grinding.
32. Nuts and rivet heads in iron safes.
33. Ends of iron columns.
34. Sad irons.
35. Moulding bits.
36. Gas fittings.
37. Locks.
38. Planing true surfaces.
39. Dies for punching.
40. Nail machinery.
41. Cutlery work.
42. Milling tools.
43. Mill bills.
44. Shoe cutters and lasts.
45. Dentists—metal and teeth.
46. Millboard.
47. Stone.
48. Agate.
49. Wood.
50. Bricks.

To this somewhat formidable list may be added many minor uses that will readily suggest themselves.

In conclusion, a few practical remarks may be offered. A common delusion prevails that an emery wheel is a tool requiring neither skill nor practice, and it is left to anyone who chooses to work it. The result of this same system, as applied to grindstones, has caused that article to assume the simply disgraceful appearance it often exhibits, untrue, worn into grooves and hollows, no one responsible for keeping it right, and the result utterly wrong. This system pursued with emery wheels is simply fatal to their chance of success.

Mount an emery wheel on a suitable machine on a rigid foundation (do not put a heavy wheel on a light spindle), run it at proper speed, checking the calculation with a speed counter, keep it always absolutely true with the diamond (a tool not half enough used), press the work lightly on to the wheel—"crowding the work" as it is called, heating more and doing less than gentle pressure; appoint a careful man to use it and make him responsible for its condition, allow him a reasonable time to learn and understand a new tool, and one possessing very great and very unusual power, and the result cannot fail to be satisfaction of the highest degree. But set an ignorant or prejudiced mechanic to a badly appointed machine, with untrue wheels, and expect him to turn out as good work in an hour as he does by other means after years of training, and the result, of course, will be disappointment and condemnation of the unfortunate emery wheel. This may be considered an overdrawn picture; any manufacturer or traveller will tell you it takes place every day. Again, do not commence your emery work by attempting to do something you cannot do with ordinary tools; get accustomed to the new system, and then apply it to the difficult jobs.

Emery grinding can no more be learnt in a day than the proper management of a lathe or planing machine. Further, give an emery wheel a fair chance by mounting it properly (at present engineers will pay hundreds for a good lathe or planing machine, yet grudge twenty pounds for a proper frame for an emery wheel), in short, put emery wheels to work they are suited for, be content to spend some time in learning to use them, and the result cannot fail to be as satisfactory in England as in America.

For ordinary fettling and general rough work, the simplest, cheapest, and quickest way is to hold the work in the hand against the wheel, occasionally dipping in water to keep it cool, a good wheel not being prejudicially affected thereby. For tool sharpening and grinding, a small stream of water under some pressure thrown on to the tool is advantageous, but if much metal has to be taken off in consequence of a deep chip, broken point, &c., it is generally the quickest plan to ignore the temper, grind rapidly, and then re-temper. For really accurate work, of course mechanical feed is essential; flat surfaces being fixed on the travelling table and traversed under a revolving wheel; cylindrical articles are rotated in a lathe, an emery wheel, fixed in a holder in the slide rest, being revolved by an independent strap, and fed against the work to be operated upon. Long bearings are desirable for the high speeds required for emery wheels, but there is no absolute rule as to material; brass bearings work well, as do white metal, and considerable success has been achieved by the new bearing called metaline, a method of treating brasses, obviating the use of oil or any other lubricant. Absolute rigidity, firm screwing home of all nuts, &c., are manifest necessities when high speed is employed.

On the table are specimens of work done by emery wheels, including—

1. Iron and brass castings fettled.
2. Locomotive slide-bars surfaced.
3. Case-hardened crank-pins turned up.
4. One minute slots, in various plates.
5. Circular saw emery sharpened.
6. Shuttle tips.
7. Lathe and other tools.
8. Stone, bricks, carbon, &c., shaped.

A solid emery wheel does not profess to polish, it cuts; and to polish there is nothing to surpass the old leather buff previously described, the elasticity of the leather rendering a very fine polish obtainable, with little or no signs of scratches; but the solid wheel prepares work admirably for the buff, and enables it to be used only for its legitimate purpose, thus causing it to last greatly longer than if used to rough down as well as polish.

Emery wheels may be improved in the future, but as at present prepared they do extraordinary work; the chief field for improvement is in the mechanical appliances to use them in. If an elaborate and expensive machine is required to actuate and utilise a simple point, it is equally required for this revolving file. Some such exist, and I now proceed to project on the screen representations of some of the more interesting English and American machines.

While the essence of emery grinding is high speed, that alone is not sufficient. I exhibit a plate with half-minute cuts made by $12 + \frac{1}{2}$ emery wheel and same size grindstone, each running at the same speed (the latter, of course, carefully protected by large side plates), showing in a remarkable manner the difference in cutting power. The respective wheels that did this work are on the table. The first cut shows little difference; but it will be observed, while the emery wheel retains its cutting powers, the grindstone rapidly loses it; until, in the fourth and fifth cut, there is an enormous difference.

I am sure I am justified in saying that the several firms now engaged in this manufacture in England will willingly give opportunity, at their respective works, to any persons here present, or their friends, to test for themselves the statements and claims put forward on this occasion; and, finally, I trust that the ventilation and discussion of this subject will lead to the more rapid introduction of one of the most wonderful labour-saving inventions since the practical application of steam, with the desire that our own country may keep pace, and hold its own proud position in the foremost rank of producers of machinery and general metal work, to the benefit of our manufacturing industries and the increased reputation and profit of both employers and employed throughout the British Isles.

DISCUSSION.

Mr. Arthur Pye Smith (of St. Pancras Iron Works) described several specimens of work which he had placed upon the table, and which had been got up by the emery wheel. This was principally used at their establishment for rougher kinds of work. A great deal was done by labourers, and by boys; as, for instance, in cleaning up common cast-iron bars, of which a boy could do from 100 to 150 in an hour. Thin cast iron, also, could be reduced by this means when it would not be safe to use a chisel for fear of breaking it, and only recently they had turned out a number of wrought iron gratings which were finished up by the emery wheel, and which they could not have done at all at the price otherwise. When they first put up the wheels, there was a good deal of prejudice against them; but, fortunately, one of their men had used them before, and was, therefore, put on

the job, and in a short time the prejudice was to a great extent overcome, but not entirely. He found the best way was to let the men who were on piecework use the wheels, and then their prejudice soon vanished; in fact, now, the men were asking for more machines. He had tried a great many different makes of emery wheels, and found some of them liable to a fault often alleged against them, namely, that they glazed, and the work stuck to the surface of the wheel; but that had never occurred with any of Ransome's wheels.

The Chairman asked if Mr. Smith had had any instances of a wheel breaking.

Mr. Smith said there were only two instances, which occurred in one day, and he found out afterwards that one of the nuts had been loosened. The man responsible for the wheels inspected them every morning, and saw they were in good order, and he did so on this occasion, and not understanding how the accident could have occurred, he made a strict investigation, when it appeared that the nut had been loosened purposely. Fortunately, no one was hurt, and nothing of the kind had occurred since.

Mr. Wentworth Scott said he could speak to the advantage of these wheels in polishing small surfaces. A short time ago a mechanical dentist submitted several specimens of work to him to examine, to see which were freest from stræi or uneven marks, and without knowing what had been the instrument or tool used in each case, he selected the surfaces which had been cut by emery wheels as superior to the others. Perhaps Mr. Bateman might be able to inform him whether he had sufficient experience of the wheels cemented together by oxychloride of magnesium to be able to say whether they would continue working for a long time without disturbing the vibration of the particles. In other words, whether an old wheel was nearly as good as a new one, or whether any radical change took place, causing a serious difference in its mode of doing its work. He should also like to know whether, in using the emery wheels for cutting magnets, you could avoid the objection, which was formed by any mechanical method of cutting the surface, that it injured the magnetism.

Mr. Sterne (of Glasgow) wished to compliment Mr. Bateman very much on his paper. He was one of the largest emery wheel manufacturers in this country, but he did not know that he had anything to add to what had been so well said. He could confirm what had been said with regard to the prejudice which existed to the introduction of any new machine. About 12 months ago two tool grinders were introduced into a large Government establishment. The two workmen employed upon them immediately complained that they had sore eyes, and wished to go into the infirmary. The foreman was kind enough to put a sheet of glass in front of the machine, but still the next two men had the same complaint. The manager stated that he thought he had one remedy, and that was to order two more machines, and since that time no less than 25 emery grinding machines have been added by the request of the men themselves. In America emery machines were in use in almost every shop.

Mr. Tepper said he had seen emery wheels used satisfactorily to cut the edges of mill-stones, and he believed they were largely used for this purpose in America. There was a prejudice amongst the workmen in England, but it was fast being overcome.

Mr. Daniel asked whether the emery wheel was applicable for every purpose for which the smallest file could be used, as, for instance, in cleaning up small cast work, such as a statuette the size of one's middle finger. This would be covered with a great number of small lines, and he should like to know whether emery wheels were capable of removing these in the same way as the small rifflers or files now used.

Mr. Botly thought it was hardly correct to say that a file could not cut anything harder than itself, because in a cutlery manufactory with which he was personally acquainted files were used to shape the different articles. He did not believe that scissors or razors could ever be polished by emery, but must be finished off with crocus.

Mr. Wilson said he would like to make a remark from the engineering point of view. Some eight years ago he had his attention called to emery grinding, and he had two wheels cemented by the oxidised oil process. He found that to grind surfaces mechanically flat, as he wanted, it required a great deal of skill on the part of the workman, and he came to the conclusion that it was of very little use to an engineer unless he had a mechanically moved table, which were not at that time made by any of the emery wheel manufacturers. He, therefore, abandoned the wheels, and made a present of them to his iron-founder, who still used them. Since then he had had some of Mr. Sterne's admirable tool-grinding machines, and was very well satisfied with them. He first had a 15-inch wheel for more than 12 months, and only about an inch was worn off it, and the tools were ground in half the time and at much less expense. Since then he had had a 3-feet wheel, which had only worn away about half an inch in six months, whereas in that time they would have worn out a grindstone costing £3 or £4.

Mr. Sterne having stated that the 3-feet emery wheel would cost £9,

Mr. Wilson said he calculated it would last two or three years, whilst they used to use a grindstone, costing £2 5s., every four months, so that he should save £7 or £8 on the cost of renewals, besides which the tools got a much finer cutting edge, and he could see the advantage in the cost of the work that was executed. So far as doing mechanical work, such as grinding up a shaft or a crank pin, he did not think they would supersede the lathe, until they adopted, in combination with the emery wheel, hydraulic forging, so that as little metal as possible was left to be taken off. If you left a quarter of an inch to be cut off, a steel tool would take it off quite as quickly.

The Chairman remarked that probably the crank pin was shaped first in the lathe, and then, being case-hardened, the emery wheel was used for the purpose of trueing up any little distortion which had arisen from the case-hardening.

Mr. Wilson said the sellers of emery wheels professed that whatever could be done in a lathe or planing machine could be done with a wheel. If you employed the system of hydraulic forging, so that the work came out almost clean, then the wheel would answer very well to finish off with.

Mr. McCullagh (North London Railway Works) said the crank pin was first forged and turned, and then case-hardened, and finished on the emery wheel. There was always a little distortion from the case-hardening.

The Chairman asked how the collars were got out. They appeared to have a good radius.

Mr. McCullagh said the emery wheel was cut to the required shape with a diamond tool.

Mr. Mather (South Western Railway) explained how the slide-bars exhibited were faced up. They got hollow in working, and used to be got up again with an ordinary copper lap and emery. They were now put in a machine having an emery wheel of 2 in. in diameter and 4 in. in width, which was made to revolve, and had also a side motion to preserve the uniformity and perfect level of the bar. Each bar took about an hour to trim up. They were hard steel, not case-hardened.

The Chairman said he understood that the bar had a longitudinal traverse under the wheel, which had a motion of rotation, and also a transverse traverse in

respect of the bar, but lengthways with respect to its spindle.

Mr. Mather said yes. They were travelled rather slowly under the wheel. For the last three months they had used metaline bearings, which appeared to answer very well. Before that they used brass bearings, which wore very quickly, on account of the small particles of emery getting in amongst the oil and being carried into the bearing by the lateral motion. They had now used the metaline bearing for three months. No signs of wear were perceptible. He was rather sceptical about a bearing without any oil, but the result seemed to be satisfactory. In reply to the Chairman, he said there was a considerable pressure on the bearing, because after the work had passed under the wheel once or twice, it was screwed down with some force.

Mr. Wilson said he had seen some machinery made by Messrs. Poole—an American firm—for trimming up the cylinders of paper-making machines. They required to be absolutely true, and it was found they could be got up better by an emery wheel than in any other way.

Mr. Blashfield asked if this method was employed at the Aberdeen works for cutting and polishing granite? He believed there was some economical method in use for working it.

Mr. Tepper, in answer to the Chairman, said that both emery and corundum wheels were used for cutting mill-stones.

Mr. Blashfield asked if he referred to French burr stones or granite.

Mr. Tepper said he had seen both cut by the emery wheel. It was done in about one-third the time occupied by hand labour.

Mr. Thomson said the small specimen of moulded stone was very nicely done, but if you were cutting a moulding 18-in. wide, and the emery wheel ground out of shape, how would you keep it in order? He was the patentee of some stone-working machinery, and had seen all the attempts to produce stone mouldings; many of these would do very well for woodwork, but it was the greatest fallacy in existence to try and produce stone mouldings with a tool of corresponding shape; it was like taking a carpenter's moulding plane and telling a mason to plane a stone moulding with it. You might get the tool in the right shape, but it would soon grind out of shape; and you could not produce one or two thousand feet of moulding alike. He agreed that the emery wheel might be useful for stone working, but only by taking a thin wheel, and so controlling it as to make it cut the required pattern. He had patented a machine in which he could use a diamond, emery, or any other tool, and the work was moved up to it by a pair of cams, which never got out of shape, because they were not exposed to wear.

Mr. Bateman, in reply, said the first question asked was as to the effect of vibration on the magnesium wheel. His purpose was not to criticise minutely different kinds of wheels, but to draw attention to the process generally. He did not know what the effect was, and if he did he should not say, because his object was not to push a commercial article, but to bring forward an industrial process. With regard to magnets, his experience had only gone to the shaping of them before magnetisation, but his impression was that the process might tend to disturb the magnetism. Magnetism might be induced by striking a bar suspended in a proper position, and very likely the jarring of the emery wheel might have an effect on a magnet. With regard to very small fine work, an emery wheel would not go into corners, nor could you get any rotary tool to perform work with the same degree of delicacy as a fine tool guided by skilled fingers. If it could be used advantageously, it would be a very small wheel on the end of a flexible shaft, and brought to bear on the required points, much in the same way as a dentist sometimes operated, by means of a small corundum wheel on the end of a flexible shaft worked by a treadle, which was in truth the parent of the American machine to which he had referred. He should be inclined to agree with Mr. Wilson that the advantage of the emery wheel was, not to remove metal by the ton but by the ounce, although it could be taken off in considerable quantities, and there were occasions in which this would be useful. In brazed tubes for instance, it was found quicker to grind a lump right off than to stop the machine and chip it. He was obliged to Mr. Tepper for his information with regard to burr mill-stones, which was new to him. He had not had much experience in stone cutting, but he tried some experiments some two years ago in Scotland, and cut a good many feet of ornamental moulding; but the specimen of stone operated on had a very remarkable formation; they occasionally came across a point of some unknown substance which struck fire with the emery wheel like hard steel, and when they came to this hard point the emery wheel got red hot for half an inch. It did the wheel no harm, but he considered this tendency to firing fatal to the process, though no doubt it was due to the peculiarity of the stone. Very probably, Mr. Thompson's plan would work better than an ornamental wheel, but a diamond tool, if used properly and sufficiently often, would keep the wheel in any desired shape. You should not wait until it lost its shape before you applied the tool. You wasted the wheel very much less by using the tool freely than by letting the wheel get out of truth and go jumping against the work. With regard to brick cutting, Mr. Reynolds, of Southwark-street, had done a great deal of admirable work in this way, and he would advise anyone interested in it to consult with him. Granite was dressed very much now-a-days; but he did not think it was done with revolving emery wheels, but by hand rubbers of different sections.

The Chairman, in proposing a vote of thanks to Mr. Bateman, said he should have liked to make some observations, but it was now too late; and he could only compliment Mr. Bateman on the admirable manner in which he had dealt with the subject, the great interest of which was shown by the attention with which it had been listened to.

The resolution was carried unanimously, and the proceedings terminated.

MISCELLANEOUS.

THE INVENTION OF THE REAPING MACHINE.

It has always been a point not quite decided whether the Scotchman Bell, or the American McCormick, was the first to construct a practicable reaping machine. The evidence appears to be strongly in favour of Bell, whose apparatus was in use from about 1826 to about 1850, shortly after which time it was purchased by Mr. Woodcroft, for the Patent-office Museum. McCormick, on the other hand, may fairly claim the credit of having been the first to bring a reaping machine into anything like general use, and there seems no doubt that the machines of our own time are the descendants, not of Bell's forgotten apparatus, but of the machine brought forward by McCormick at the 1851 Exhibition, and patented, by him seventeen years before in the United States (1834).

It is, of course, well known that many other inventors had previously attempted to gain the desired object by means more or less effectual. Revolving cutters were tried as far back as 1799, while two inventors,

at least* (Salmon, 1807, and Ogle, 1822) had reciprocating knives, or frames fitted with knives, which resembled, to a certain extent, the cutters now used. These last had, however, no shearing action, and it is precisely this shearing or drawing cut that alone answers for cutting corn. Such an action is found in Bell's and in McCormick's machines, but there now seems some reason to believe that both these were anticipated by John Common, of Denwick, Northumberland. The following extract from the old MS. Committee Minutes of the Society of Arts does not appear to have been seen by writers on the subject, and it almost certainly has never been printed. The extract is from the minute book for the Session 1811-12:—

"Took into consideration a reference to this committee of April 15th, 1812, on a reaping machine. Read two letters from Earl Percy, dated 8th and 14th April, 1812, stating that he had sent to the Society the model of a machine for reaping corn, barley, oats, &c., made by John Common, of Denwick, Northumberland; that he is not quite certain whether a sufficient trial of the machine has been made to authorise its being laid before the Society, as the inventor, Mr. Common, partly from the fear of any person stealing his invention, and partly from the want of more extensive means, did not cut more than ten or twelve sheaves, but in this experiment the machine acted with great precision. That the two persons who assisted Mr. Common are the only persons who have seen it act and have sent certificates respecting it.

"Read a certificate from John Thew and Thomas Appleby, dated Denwick, April 9th, 1812, stating that they accompanied John Common to a field at Denwick to make trials of his newly-invented reaping machine, where they saw it cut down a small patch of ripe oats with ease and dispatch, and that they are of opinion it will answer the purposes intended, and be of general benefit to the country.

"Examined the model sent. The apparatus is to be drawn by one or more horses, and is of considerable length; it appears that the two large wheels, from whence motion is given to the machine, are to be made of wood and iron spikes fixed in their periphyræ; they are fixed upon an axle of iron which moves round with them, and which axle also turns round a brass wheel fixed upon it, the teeth of which work in a pinion placed on a longitudinal axle, on the other end of the spindle or axle near to the shafts is fitted another cogd wheel, the teeth of which work in a pinion below, supported by a small wheel to prevent this part of the machine from touching the ground. The pulley and pinion last mentioned give an alternate backward and forward motion to a set of angular knives, so as to enable them to act upon a principle similar to the action of a number of scissors upon the blades of corn, directed to them by angular spikes of iron projecting before them as it falls upon a set of rollers, from whence it is delivered in a line upon the earth, as described in an account sent with it.

"Resolved,—It appears to this committee, upon inspecting the model of Mr. Common's reaping machine, and reading the account thereof with the certificate produced, that this invention is incomplete, and at present they cannot fairly judge of it, and therefore cannot recommend it to the further attention of the Society."

The description is certainly somewhat meagre, but as far as it goes it is sufficient to show that the main principle of the reaping machine was known and had been experimented with, at least, thirteen years previous to the date generally allotted to the invention.

Another machine brought before the Society of Arts, but apparently not elsewhere mentioned, is one by Amos, of Boston, Lincolnshire. In it "a number of scythes are caused to revolve rapidly by the usual adaptation of wheels and pinions." The committee had this brought before them in 1820, and decided that "the plan, however, was not new, and it has been found by experience that it is impossible to apply to this construction power enough to produce a sufficiently rapid motion of the scythes."

Bell's machine came before the Society in 1830, but was not rewarded, on the ground that the descriptions of the machine already extant had brought it sufficiently before the public, and that it did not therefore require the Society's aid in bringing it into notice.

* See Appendix to Specifications of Reaping Machines. By B. Woodcroft, 1853.

IMPERISHABLE WATER-COLOURS.

Some recent discoveries in this direction have been made by M. Alfred Méry. His experiments date as far back as 1804; at first he was only able to produce water-colour drawings, pastels, or what seemed like pastels, but executed with the brush. Subsequently improvements were effected, and it is now said that the colours treated after his method are employed precisely in the same manner as those mixed with oil, and produce precisely the same effect. Besides being more solid than any body colour not mixed with oil, works executed with the new vehicle will remain a fortnight actually in water without injury. Moreover, the colours may be dried at will, or kept moist altogether, or in part only, either in the palette or on the work, and may be re-wetted wholly or partially, and for any desired time.

The composition of the vehicle employed is not stated, we are only told that it contains certain extremely adhesive substances, pure wax being one; that most of the elements of the composition are insoluble in water yet are readily thinned by its means; and that this vehicle renders the colours used unalterable. M. Méry prepares his colours months in advance, and carmine which he has kept for fourteen years has undergone no change. The mixed colours are kept under water, and are said to lose none of their qualities.

Paintings produced with these colours in imitation of pastels, may be finished with the stump when dry; these and water-colour drawings are produced with a moderate amount of colour carefully ground in water; for oil painting, more colour is added, and wax colours are thus produced containing neither oils nor acids with the same consistency and the same appearance as those mixed with oil. They are used in precisely the same manner, only water is used for reduction and glazing instead of oil. They are declared to be more permanent than any other known, and equally adapted for all applications artistic or industrial, and on all substances, wood, marble, glass, paper, prepared canvas, &c. A few minutes suffice to dry the paintings, and when dried they may be washed repeatedly without injury. Wall decorations executed with these colours are unaffected by humidity.

The colours are declared to possess all the freshness and the tone of oil, and as becoming, after a time, as hard as stone or cement, and containing neither oil nor acid which can decompose the wax. When varnished and moistened, the aspect of these paintings is that of works in oil, having all their vigour, transparencies, and glazing, and the presence of the wax allows of the result being obtained by simple friction. One great advantage attributed to the discovery is that an artist may carry as many sketches as he can produce in an ordinary portfolio without the slightest danger of injury to them.

It is claimed for the new vehicle that with it a student has only to learn the use of one kind of pigment, whatever may be the work he is to do, artistic or decorative; and it is equally applicable to china and glass painting with fusible colours, and with the great advantage of perfect facility in repairing or heightening any portion.

It is suggested that M. Méry has rediscovered the lost method of eucaustic painting. Many ancient painters worked in eucaustic, which is described as being applied and fixed by means of fire.

ADULT INSTRUCTION THROUGH PUBLIC MUSEUMS.

(Subsidised by Parliament.)

The following results, giving important information bearing on public education, are obtained as correctly as possible, from inquiry and Parliamentary returns, in the hope that they may hereafter be officially collected and published periodically, like the Registrar-General's returns. The number of visitors for the month of February, 1878, are stated. When they are counted by sight the letter "S" is used, when by turnstile the "M":—

INSTITUTIONS.	Amounts voted in 1877.	Number of Visitors in February.	How counted.	OBSERVATIONS.
	£			
1. British Museum	109,990	**28,329**	S	Return refused. Open Mondays, Wednesdays, Fridays, and Saturdays. Closed, except to students, on Tuesdays and Thursdays. (1)
2. National Gallery, Charing-cross	6,976	84,277	S	Open Mondays, Tuesdays, Wednesdays, and Saturdays. Closed on Thursdays and Fridays. Open from 10 to 6. (2)
3. Kew Gardens and Museum	22,622	14,017	S	Open on Sundays and week days. (3)
4. South Kensington Museum	38,922	61,255	M	Open morning and evening till 10, on Mondays, Tuesdays, & Saturdays. Students' days—Wednesday, Thursday, & Friday, 6d. entrance. Open from 10 till Sunset.
5. Bethnal-green Museum	7,600	38,533	M	Ditto. (5)
6. National Portrait Gallery, South Kensington	2,000	..	M	Return refused. Open daily except Sundays. (6)
7. School of Mines and Mining Record Office, Geological Museum, Jermyn-street	8,997	4,289	M	Open daily, except Sundays and Fridays, and in the evenings till 10 of Monday, Tuesday, and Saturday. (7)
8. Patent Office Museum, South Kensington	..	14,556	M	Open daily, except Sundays. (8)
9. Edinburgh National Gallery	2,100	5,844	M	(9)
10. Edinburgh Museum of Antiquities	..	4,660	M	(10)
11. Edinburgh Museum of Science and Art	10,998	34,461	M	Open daily (10 a.m. to 4 p.m.) except Sundays, and Friday and Saturday evenings (6 to 9). Students' days—Monday, Tuesday, & Thursday; admission 6d.; other days, admission free. (11)
12. Edinburgh Botanic Gardens	1,750	3,343	M	(12)
13. Dublin Museum of Natural History	1,762	7,094	M	Open daily, & in the evening. (13)
14. Glasnevin Botanical Gardens and Museum	2,224	9,692	M	Open daily, including Sundays. (14)
15. National Gallery of Ireland	2,389	..	M	(15)
16. Museum of Royal Irish Academy, Dublin	300	..	M	(16)
17. Zoological Gardens, Dublin	500	5,134	M	Open daily, including Sundays. Number of visitors in July, 15,281. (17)
18. Tower of London	1,590	19,513	S	Open daily, except Sundays. (18)
19. Royal Naval College, including Greenwich Painted Hall	38,051	23,402	S	Open daily, including Sundays. (19)
20. Royal Naval Museum, Greenwich	1,055	2,523	S	Open daily, except Fridays and Saturdays. (20)
21. India Museum, South Kensington	..	1,252	M	Paid for by Indian Government. Open on Mondays, Tuesdays, Fridays, and Saturdays, 1d. admission; on Wednesday and Thursday, 6d. admission. (21)
22. Hampton Court Palace	7,475	2,375	..	Open on Sundays, and on week days except Fridays. (22)

(1) The numbers are those for the corresponding month of the previous year, as given in the Parliamentary Return.
(2) Open to the public 16 days, from 10 to 5 o'clock. Number of visitors in January (open 15 days, 10 to 4 o'clock), 80,179. Received too late for insertion last month.
(7) Number of visitors in the morning, 2,284; evening, 2,005—total, 4,289.
(11) Total number of visitors during 1877, 372,585.
(13) Visitors in the daytime, 1,997; evening, 5,097—total, 7,094.
(14) Visitors on Sundays, 6,890; week-days, 2,802—total, 9,692.
(15) (16) No information as to opening.

COOKERY AN ART FOR GENTLEWOMEN.

"Common Sense" writes thus recently to the *Times*:—"I have just eaten a very indifferent dinner, prepared for me by a cook to whom I pay £40 per annum, besides finding her in food and lodging, a separate bedroom, washing, &c., equal to another £35 per annum at least. That she may be able to devote her energies to her sole business—that of cooking—I keep a kitchenmaid, who does absolutely nothing but attend upon my cook aforesaid, and costs me, with her keep, another £50 per annum. For six weeks past my wife has been scouring Manchester, Liverpool, and even London, for a sober, respectable woman, who, for the advantages above enumerated, would undertake the duties of cooking for my household, which consists of two young children and five servants, in a small and exceptionally good and convenient house, situated in a healthy and fashionable seaside neighbourhood. My wife only requires that her cook should be able to prepare a dinner for twelve guests without the assistance of the professional cook, whose abominations are only too well known. So far, not a single candidate in the slightest degree suitable has presented herself. In the frame of mind engendered by these facts, I have been reading in your columns the various letters as to the employment of women, and, notably, Miss Emily Faithfull's communication. May I be allowed to ask whether the higher education of women is the only thing required to enable them to obtain a livelihood, or whether, so long as I have such an opportunity of obtaining a livelihood to offer, any correspondent of Miss Faithfull is justified in saying that 'women's special right seems a right to starve?' As a matter of fact, I have been a housekeeper for nineteen years. I have kept my servants on an average for at least seven years each, and I cannot, therefore, be very difficult to please. But I say this unhesitatingly—that I cannot get an uneducated woman to cook for me as well as I could learn to cook for myself in a month for a remuneration much higher than would obtain for me in one week the services in my business of a hundred educated gentlemen, many of them with families of their own to maintain. I would ask Miss Faithfull and her friends how they can reconcile my case, which is the case of thousands, as they must well know, with the absurd talk of women starving for want of employment. Women starve, not for want of employment, but, sad to say, from sheer inability to fit themselves for it. The gastronomic art has always been one which, if not in itself noble, is very closely allied to the noble arts, and is not unworthy of the study of both men and women. It requires genius, no doubt, though certainly not genius of the highest order. As it is, never was the adage that 'God sends meat, and the devil cooks,' so true as at the present moment. I would venture to submit that before women complain that 'their mission is to starve' they should see whether educating themselves to prevent starvation in others with most liberal terms for so doing is an impossible fact. I am, sir, a sincere admirer of the many virtues and qualities of the sex, and I feel a profound regret that those ladies who profess to interest themselves in the well-being of their fellow-women should point to that *ignis fatuus* the competition with men in the highest walks of art and science while the performance of the commonest duties assigned to their sex from the creation of the world cannot be secured on liberal terms."

The revenue of the Post-office Telegraphs for the year ended the 31st day of March, 1877, amounted to £1,328,315, from which £1,120,211 had to be taken for salaries, wages, maintenance, &c., and £13,290 as a contribution to a depreciation fund to replace submarine cables. This left a balance of profit of £194,814, equal to 1·97 per cent. on a capital of £9,845,278.

REQUIREMENTS OF THE EDUCATION OFFICE.

Mr. William Douglas Parish, from Selmeston, writes to the *Times* of 26th February, to complain of "the enormous accumulation of work which is being thrown upon them by the Education Department. Within the last few weeks the teachers have been called upon to make such elaborate returns under the Act of 1876, that I know many who were obliged to forego their Christmas holiday in order to do this work, for which they received no remuneration whatever. Let me give a specimen of the demands which are made upon us. A few years ago I was astonished to find that I was expected to fill up printed forms with upwards of 800 entries, previous to the visit of the inspector to our little school of 72 children. To-day I have notice of inspection for the same number of children, on whose behalf I am to make no less than 2,247 entries, many of which involve intricate calculations, and all of which must be verified by reference to four or five different books. All this is done to satisfy the stupid demands of the Parliamentary Pharisees and the Scribes of the Education-office, who increase our burdens day by day, and hold out no finger to our assistance or hand to our encouragement. So well is the Department informed already upon all these matters that if one of my 2,247 replies should be incorrect, it will be detected immediately, and the grant to the school withheld till it is set right. What are they but snares for entanglement? If it could only be known what these my Lords Mint, Anise, and Cummin exact of us, I think we might be delivered from their bondage."

It has been suggested that it would be a suitable inquiry for some friend of education to make, to find out if some system of substituting local for central management might not be substituted. In the annual report for 1876-7, p. 371, is given the annual income of elementary schools, and it appears that local funds, such as endowments, voluntary contributions, school pence, fees, rates, &c., amounted to £2,129,315, whilst the Government payments amounted only to £1,111,564, little more than half. Might not the local management and control stand in the same proportion? affording increased government economy and local comfort?

CORRESPONDENCE.

INDIAN IRRIGATION.

I am much obliged to Mr. Maitland for (in his letter of the 6th inst.) directing attention to the imperfect and inaccurate report of the remarks I made in the course of the discussion on Mr. Thornton's paper on "Indian Irrigation." What I endeavoured to show on that occasion was, that, taking into consideration the enormous liabilities of the Indian Government, it would be unwise to add to them by borrowing (as was proposed by Mr. Bright) large sums for irrigation, or for any other works whatever.

In order to support my position, I next showed that if we compared, for instance, the liabilities and dependable income of India, with the liabilities and income of England, we could then form some idea of the amount of the liabilities of our Indian Empire. I then stated that these liabilities were more than six times the revenues paid by the people of India, whereas the liabilities of England were less then ten times the amount paid into the Treasury. I arrived at the latter conclusion by looking at the Statesman's Year Book of Facts, and at the former by economising the published account of the revenues of India for the year ending March 31st, 1876. The total revenue of India then given amounts to £51,310,063. Add up the items which the people

pay—land revenue, salt, stamps, excise, customs, forest, mint, post-office, telegraphs, law and justice, and miscellaneous—and you will arive at the real revenues of India, which amount to (and I have given the most favourable view) £38,251,560. As to the balance, it is derived from opium to the extent of £8,471,425, and the residue consists of items which are realties of account with a corresponding set-off on the side of expenditure. When I prepared this statement (which I did for my lecture of November 20, 1877, delivered at a meeting of the Colonial Institute) I went to the trouble of taking the proofs to the India-office, to be looked over by the most competent authority there on the subject.

I observe that Mr. Maitland objects to the railways being included in the liabilities of the Indian Government. If India was peopled by Englishmen, there might be something to be said in favour of his objection, but, till it is so, there must always be the possibility of disasters arising which might throw the whole burden of the guaranteed interest on the Government; and as long as that is so, I am afraid we must always regard our railways as what they legally are—Indian liabilities.

Permit me to add, in conclusion, that those who are urging the Indian Government to add to its already enormous liabilities are taking upon themselves a very serious responsibility. Our own English debt is large, but taking into consideration the resources we have to draw upon, it is trifling compared to that of India; and then it must never be forgotten that Indian liabilities have most disagreeable features, and they are nearly all held by Englishmen. If they were held to any amount by the natives of India, some security for order would thus be afforded. But to add to a public debt which has all the disadvantages of debt, without one single redeeming point, is a matter I need not further write about. As I observed in my remarks after the conclusion of Mr. Thornton's paper—"If you could borrow 100 millions from the natives, and be sure that they would hold the stock, I would borrow it at once for irrigation, or, at least, as soon as could be profitably expended."

Robert H. Elliot.

38, Park-lane, W., March 17th, 1878.

A CORPS OF INDIAN HUNTSMEN.

The lecture recently delivered at the Society of Arts by Sir J. Fayrer, on the "Destruction of Wild Animals and Venomous Snakes in India," which was reported at full in the Society's *Journal*, recalls to my mind a project which I put forward, and which was printed in these pages several years since. That project was for the institution of a military body under some such title as that above. In 1875, 20,805 persons and 54,820 head of cattle; and in 1876, 19,273 persons and 54,830 head of cattle were destroyed by predatory animals and by venomous snakes. The special duty of the proposed corps would be that of systematically destroying wild beasts, &c. This corps should be a branch of the Indian army, as it would, under certain possible eventualities, by its mobility and intimate knowledge of the country, be of the highest possible utility in a military point of view. Such a corps would, in all probability, be very popular with adventurous spirits. A force might, of course, be detailed from the Indian army for this special duty, but that would do away with an additional inducement to enlistment.

Captain Rogers, in 1868, proposed to organise the Shikarees of every district into regular bands, with Zimadars over them, and to supply them with rifles and amunition, exempting these selected Shikarees from the usual payment for license to carry fire-arms, &c. This scheme, however, for various reasons, was not approved by the Indian Government. The proposed corps might not only successfully accomplish a very important special service, but prove a very valuable contingent to the Indian army.

W. Cave Thomas.

53, Welbeck-street, March 14, 1878.

MR. B. FRANCIS COBB'S PAPER ON "EGYPT."

Will you allow me to correct a few of the figures contained in the paper read last evening by Mr. B. Francis Cobb, on "Egypt," at the meeting of the African Section of the Society?

The export of cotton from Egypt during 1876 was 3,631,349 cantars = 575,000 bales (of 600 lbs. each); that of what in the same year was 903,437 ardeps = 560,000 quarters; and that of sugar 743,440 cantars = 70,627,000 lbs. I may add that during the same period Egypt exported 1,043,967 ardeps of beans = 679,000 quarters.

J. W. Agelasto.

22, Pembridge-crescent, W., 20th March, 1878.

OBITUARY.

Ellis A. Davidson.—Mr. E. A. Davidson died on the 9th inst., after a long and lingering illness, which for nearly three years had prevented the continuation of the various works on which he was engaged. One of the first Art teachers under the Science and Art Department, he was for many years at the Chester Diocesan Training College under the Rev. Arthur Rigg. After this, he was Art Master at the City Middle-class School, and when he resigned this post, he devoted himself almost entirely to the superintendence of the various technical publications brought out by Messrs. Cassell, Petter, and Galpin. He was also the author of several technical works besides the great number which he edited for that firm. In 1867, Mr. Davidson read a paper before the Society on "Industrial and Scientific Education," and in 1869 he followed this up with a second paper on "Industrial Education for Females." He was a frequent attendant at the Society's meetings, and an occasional contributor to the *Journal*. He became a member of the Society in 1868, and retired last year on account of his failing health.

GENERAL NOTE.

Importation of Fresh Fish from America.—A correspondent sends the following account of some importations of fish in ice from America. The experiment is now being tried by Messrs. Tallermann, at their "cold storage wharves," in Cannon-street:—There were several fine salmon from New Brunswick, and pickerel and white fish from the Detroit and Lake Huron waters. The pickerel is a common fish in the States and Canada, and appears to be a kind of cross between our pike and perch, having the spinous back fin of the latter; and it is not unlike the basse, or sea dace (*Labrax lupus*). The white fish (*Coregonus albus*) is of the salmon family, as shown by the adipose fin between the tail and dorsal fin. It is a close ally of the gwyniad of the lake district, now almost extinct, the powace of Ireland, and the vendace of Scotland. The Irish fish just mentioned, from its herring-like appearance, is sometimes called the "fresh water herring," and in America some of the species are known as the "herring salmon." The long refrigeration to which the fish in question had been subjected, did not seem to have affected their flavour, which is a fact to be noted. They came out of the barrels in solid masses, hard as brickbats, the pickerel and white fish weighing from 2 lbs. to 5 lbs. each. They tasted most excellent when cooked, plain broiled. The pickerel had a distinct jack flavour, but the flesh was firmer than that of our pike, and free from the objectionable bones which infest that fish. The white fish, ranging in weight like the pickerel, were far the superior

of the two. The colour of the flesh is naturally bluish white, but becomes quite white when cooked. It is very solid, and "flakes" like salmon, a flavour of which is palpably discernible. There is, too, a flavour suggestive of mackerel. The back and shoulders of the fish in question were loaded with fat, and the stomach was very thick. The importation of these fish, especially the *Coregonus albus*, for the first time into this country, will also be a matter of interest to anglers, as their acclimatisation has long been promised. They are both good sporting fish, and the *Coregonus* is so prolific that it multiplies in almost incredible numbers in water suited to it. But our concern is mainly with the importation of these fish as adding to our food supply. It is calculated that the New Brunswick salmon could be sold here at about 9d. per lb., or less, and the pickerel and white fish at about 4d. per lb.

NOTICES.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at eight o'clock.

March 27.—"State Aid to Music at Home and Abroad." By Alan S. Cole, Esq.

April 3.—"Our Wealth in Relation to Imports and Exports, and the causes of Decline in the latter," by E. Seyd, Esq. W. Hawes, Esq., F.G.S., will preside.

April 10.—"A New Method for Producing Cheap Heating Gas for Domestic and Manufacturing Purposes." By S. W. Davies, Esq., A.R.S.M.

African Section.

Tuesday evenings, at Eight o'clock.

April 16.—"The Progress of Agriculture and Stock Farming in the Colony of Natal." By Peter C. Sutherland, Esq., M.D., Surveyor-General of the Colony. The chair will be taken by J. A. Froude, Esq.

Chemical Section.

Thursday evenings at eight o'clock.

March 28.—"Electric Lighting," by Dr. Paget Higgs.

April 25.—

May 9.—"Some Recent Improvements connected with Alkali Manufacture." By James Mactear, Esq.

Indian Section.

Friday evenings at eight o'clock.

March 29.—"The Depreciation of the Value of Silver, with Especial Reference to the Exchange between England and India, and Suggestions for a Remedy." By Col. J. T. Smith, R.E., F.R.S., formerly Master of the Mint, Madras and Calcutta. Andrew Cassels, Esq., will preside.

May 3.—"The Telegraph Routes between England and India." By Major Bateman-Champain, R.E.

May 17.—"Agriculture in India." By F. C. Danvers, Esq.

Cantor Lectures.

Monday Evenings, at Eight o'clock. Second Course, on "The Application of Photography to the Production of Printing Surfaces and Pictures in Pigment." By Thomas Bolas, Esq., F.C.S.

Lecture VI.—March 25th.

Other methods of producing photographs in pigment. Dusting-on method. Autotype printing.

Third Course, on "Some Researches on Putrefactive Changes, and their Results in relation to the Preservation of Animal Substances." By B.W. Richardson, Esq., M.D., F.R.S. April 8, 15; May 6, 13, 20, 27.

MEETINGS FOR THE ENSUING WEEK.

Mon.....SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Thomas Bolas, "The Application of Photography to the Production of Printing Surfaces and Pictures in Pigment." (Lecture VI.)
Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. H. B. Cotterill, "Lake Nyassa, and his Journey from its Northern end, *via* Ugogo, to Zanzibar."
Institute of Actuaries, The Quadrangle, King's College, W.C., 7 p.m. Mr. A. H. Bailey, "The Principle to be observed in the Valuation of Life Assurance Companies."
Medical, 11, Chandos-street, W., 8 30 p.m.
London Institution, Finsbury-circus, E.C., 5 p.m. Mr. R. A Proctor, "The Old Age of a Planet."

Tues....Royal Institution, Albemarle-street, W., 3 p.m. Prof. Garrod, "The Protoplasmic Theory of Life and its Bearing on Physiology." (Lecture XI.)
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. Henry Davey, "Direct-Acting, or Non-Rotative, Pumping Engines and Pumps."
Anthropological Institute, 4, St. Martin's-place, W.C., 8 p.m.

Wed....SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Alan S. Cole, "State Aid to Music at Home and Abroad."
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 pm Dr. C Mansfield Ingleby, "The Literary Career of a Shakespeare Forger."
Society for the Development of the Science of Education, United Westminster (Endowed) Schools, Alexandra-street, Victoria-street, S.W., 7.30. Miss Sheriff, "Fröbel's Principles of Education."
Royal College of Physicians, Pall-mall East, S.W., 5 p.m. (Croonian Lectures.) Dr. Pavy, "Points Connected with Diabetes." (Lecture I.)

Thur....SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Chemical Section.) Dr. Paget Higgs, "Electric Lighting."
Royal, Burlington House, W., 8½ p.m.
Antiquaries, Burlington House, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 7 p.m. Prof. J. Ella, "Chamber Music." (Illustrated Musical Lecture, Part II.)
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Chemistry of the Organic World." (Lecture X.)
Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.
Philosophical Club, Willis's-rooms, St. James's, S.W. 6½ p.m.

Fri......SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Indian Section). Col. J. T. Smith, "The Depreciation of the Value of Silver, with Especial Reference to the Exchange between India and England, and Suggestions for a Remedy."
Royal United Service Institution, Whitehall-yard, S.W. 3 p.m.
Royal Institution, Albemarle-street, W., 8 p.m., Weekly Meeting. 9 p.m., Professor Dewar, "The Chemical Actions of Light, and their Electrical Relations."
Royal College of Physicians, Pall-mall East, S.W., 5 p.m. (Croonian Lectures). Dr. Pavy, "Points Connected with Diabetes." (Lecture II.)

Sat......Working Men's Club and Institute Union (at the House of the Society of Arts), 4 p.m.
Chemical, Burlington House, W., 8 p.m. Annual Meeting.
Physical, The Science Schools, South Kensington, S.W., 3 p.m. Mr. W. H. Preece, "Byrne's Pneumatic Battery."
Royal Institution, Albemarle-street, W., 3 p.m. Rev. W. Houghton, "Natural History of the Ancients." (Lecture III.)

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,323. Vol. XXVI.

FRIDAY, MARCH 29, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

NATIONAL WATER SUPPLY.

The following letter has been addressed by the Council of the Society to a select list of authorities on the question of water supply:—

Sir,—I am directed by the Council of the Society of Arts to request the favour of your attention to the letter which his Royal Highness, President of the Society, has recently addressed to the Council. A copy of the letter in full is enclosed.*

The Council desire to lay before his Royal Highness the opinions of the most eminent authorities on the subject of water, and on the practicability of giving to the people generally the benefit of those supplies which nature provides in so great an abundance.

With this view, it is intended, some time in the month of May, to hold a Congress for the discussion of the subject as suggested in the letter of his Royal Highness. The Council would, in the first instance, venture to ask you to state briefly, whether you believe a large and comprehensive scheme of a national character, as suggested, to be practicable. If so, I am to ask you to state as briefly as convenient to you the broad features of such a scheme.

The Council hesitate to tax your kindness too much, but they would be gratified if you would, with a view to such a discussion, prepare a short sketch embodying your views, which might be printed, and which you might amplify by speaking at the meeting. Due notice of the day fixed for the Congress will be sent you.

In the meantime the Council hope you will favour them with an early reply.—I am, Sir, your obedient servant,

P. Le Neve Foster,
Secretary.

ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1878, early in May next. This medal was struck to reward "distinguished merit in promoting Arts, Manufactures, or Commerce," and has been awarded as follows:—

In 1864, to Sir Rowland Hill, K.C.B., "for his great service to Arts, Manufactures, and Commerce, in the creation of the penny postage, and for his other reforms in the postal system of this country, the benefits of which have, however, not been confined to this country, but have extended over the civilised world."

In 1865, to his Imperial Majesty, Napoleon III., "for distinguished merit in promoting, in many ways, by his personal exertions, the international progress of Arts, Manufactures, and Commerce, the proofs of which are afforded by his judicious patronage of Art, his enlightened commercial policy, and especially by the abolition of passports in favour of British subjects."

In 1866, to Professor Faraday, D.C.L., F.R.S., for "discoveries in electricity, magnetism, and chemistry, which, in their relation to the industries of the world, have so largely promoted Arts, Manufactures, and Commerce."

In 1867, to Mr. (now Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S., "in recognition of their joint labours in establishing the first electric telegraph."

In 1868, to Mr. (now Sir) Joseph Whitworth, F.R.S., LL.D., "for the invention and manufacture of instruments of measurement and uniform standards, by which the production of machinery has been brought to a state of perfection hitherto unapproached, to the great advancement of Arts, Manufactures, and Commerce."

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, Foreign Member of the Royal Society, Chevalier of the Legion of Honour, &c., "for his numerous valuable researches and writings, which have contributed most importantly to the development of food economy and agriculture, to the advancement of chemical science, and to the benefits derived from that science by Arts, Manufactures, and Commerce."

In 1870, to M. Ferdinand de Lesseps, "for services rendered to Arts, Manufactures, and Commerce, by the realisation of the Suez Canal."

In 1871, to Mr. (now Sir) Henry Cole, C.B., "for his important services in promoting Arts, Manufactures, and Commerce, especially in aiding the establishment and development of International Exhibitions, the development of Science and Art, and the South Kensington Museum."

In 1872, to Mr. Henry Bessemer, "for the eminent services rendered by him to Arts, Manufactures, and Commerce, in developing the manufacture of steel."

In 1873, to M. Michel Eugène Chevreul, F.R.S., "for his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history, which for more than half a century have exercised a wide influence on the industrial arts of the world."

In 1874, to Mr. W. C. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the Arts; and for his improvement in the manufacture of iron; and generally for the services rendered by him in connection with economisation of fuel in its various applications to the Manufactures and the Arts."

In 1875, to M. Michel Chevalier, "The distinguished French statesman, who, by his writings and persistent exertions, extending over many years, has rendered essential service in promoting Arts, Manufactures, and Commerce."

In 1876, to Sir George B. Airy, K.C.B., F.R.S., the Astronomer Royal, "for eminent services rendered to Commerce by his researches in nautical astronomy, and in magnetism, and by his improvements in the application of the mariner's compass to the navigation of iron ships."

In 1877, to Jean Baptiste Dumas, F.R.S., member of the Institute of France, "the distinguished chemist, whose researches have exercised a very material influence on the advancement of the Industrial Arts."

The Council invite members of the Society to forward to the Secretary, on or before the 20th of April, the names of such men of high distinction as they may think worthy of this honour.

* See *Journal* of 15th February.

CANTOR LECTURES.

The sixth and concluding lecture of the second course, on "The Application of Photography to the Production of Printing Surfaces and Pictures in Pigment," by Mr. Thomas Bolas, F.C.S., was delivered on Monday evening last, the 25th inst. These lectures will be published in the *Journal* during the recess.

SIXTEENTH ORDINARY MEETING.

Wednesday, March 27th, 1878; Lieut.-Colonel Sir E. Du Cane, K.C.B., R.E., Member of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Attler, Henry, Westcott, Putney.
Chater, George, Jun., 68, Cannon-street West, E.C.
Hehner, Otto, F.C.S., 54, Holborn-viaduct, E.C.
Kyd, Hayes, Wadebridge, Cornwall.
Sawyer, John Robert Mather, Brownlow-house, Ealing Dene, W.
Wright, Caleb, Lower-oak, Tyldesley.

The following candidates were balloted for and duly elected members of the Society:—

Bourke, W. Roston, 37, Devonshire-road, N.
McKerrow, John Begg, Norcliffe, Broughton-park, Salford.
White, J. T., 4, Clarendon-place, Hyde-park-gardens, W.
Williams, C. J., 29, Albert-square, Clapham, S.W.
Woodford, Rev. A. T. A., 10, Upper Porchester-street, W.
Young, H., 50, Grosvenor-road, S.W.

The paper read was—

STATE AID TO MUSIC, AT HOME AND ABROAD.

By Alan S. Cole.

The cultivation of those senses which the knowledge and practice of the science and art of music call into operation is, I presume, at least, as much an obligation as any other cultivation of the senses. All civilised nations seem to recognise this as a truth and act on it. Shakespeare's lines, that "the man that hath no music in himself, nor is not moved by concord of sweet sound, is fit for treasons, strategems, and spoils," offer themselves appropriately to those who propose to question the value of a national cultivation of the science and art of music, if there are any such persons.

Six years ago, at the London Institution, Professor Ella said:—"In the days of Queen Elizabeth a well-educated gentleman could read his part in a madrigal, and the Court was well supplied with learned musicians. The present move in favour of elementary musical education in Government schools, I trust, may be followed by a grant to promote the higher branches of scholastic education, for the church, the concert, and a lyrical theatre. It is humiliating to think that this rich and mighty city, of three millions of inhabitants, has no national academy of music, no public library, no institute, no national opera, and not a single orchestra or choir consisting of native professors; and whilst 1,500 of the youth of both sexes in Vienna, Paris, and Brussels, are receiving the best possible gratuitous instruction in music, our Royal Academy of Music, relying chiefly on the precarious support of voluntary subscription is obliged to charge so highly for instruction that few pupils are able to remain long enough to complete their education. Should the noble structure (the Royal Albert-hall) lately erected at Kensington, ultimately lead to the establishment of a National Musical Academy, institute, and library, we shall have additional cause to bless the memory of the lamented Prince, to whom it is dedicated in commemoration of his wisdom, virtues, and genial sympathy for the Fine Arts."

It is not within the province of my paper to attempt to touch upon all the points raised in the extract I have just read. My duty this evening is to try and bring before you a few of the facts relating to some of the means adopted for securing national musical cultivation, and as State aid is perhaps regarded as one of the most important of these means, I have ventured to select for the subject of my paper, "State Aid to Music, at Home and Abroad."

A manner in which aid is granted by the State to promote the general cultivation of the people of this country is distinctly marked. Payments are made for ascertained results or for the fulfilment of certain conditions. In compiling my notes, I have tried to keep before me circumstances such as these and others bearing on the main subject of my paper, and I propose to refer to those circumstances and their results in such a way as to show that, even during the six years since Professor Ella lamented over the condition of national musical cultivation, progress of a distinct kind has been made.

Many of you are probably aware that amongst the numerous works initiated or assisted in development by the Society of Arts, the promotion of national musical instruction occupies a prominent place. In 1865 the Society appointed a committee to inquire into and report on the state of musical education at home and abroad. The committee met during the months of May, June, and December, 1865, and January and February, 1866. With the ready assistance of those interested in musical education, the committee collected evidence on the subject, and many gentlemen connected with the musical profession attended the meetings of the committee. The late Sir Sterndale Bennett, Sir Julius Benedict, Sir Michael Costa, Mr. C. Lucas, Mr. G. Macfarren, Sir F. Gore Ouseley, Herr E. Pauer, M. Otto Goldschmidt, Mr. Turle, and Dr. Wylde all gave evidence, and supplied the committee with valuable information and opinions. Besides the above-named gentlemen others, such as the late Mr. H. F. Chorley, the late Sir George Clerk, the late Mr. Harry Chester, Mr. J. B. Capes, and Sir Henry Cole gave evidence. Mr. Le Neve Foster visited some of the Conservatoires abroad, and the Secretary of State for Foreign Affairs was pleased to comply with a request of the committee, and to direct her Majesty's representatives abroad to collect papers and prospectuses relating to other large foreign Conservatoires. The evidence and documents obtained through the

agency of this committee have been published, and afford a reliable source of information, in regard to the charaeter of the instruction given at foreign Conservatoires, the class of students under instruction, and the financial support which these Conservatoires receive. In addition to the volume of printed papers, I have had the advantage of visiting the Conservatoires at Liège, Vienna, and Paris, and of acquainting myself with the charaeteristics of these institutions.

So far, then, as I know, the two characteristics which appear to me to be the essential features of Conservatoires de musique are—(1), a graduated curriculum of obligatory instruction; and (2), the free-giving of such instruction to proved competent natives of the country in which the Conservatoire is established.

Bearing these two characteristics in mind, it may surprise many to hear that in England, until 1876, we had no Conversatoire de musique or musical academy or school possessing such characteristics. Musical instruetion in this eountry has been left to look after itself on the *laisser faire* principle. Those who wanted musieal instruction have had to pay for it; they eould buy whatever they thought they liked. In these circumstances many institutions, as admirable as the conditions of their birth have permitted them to be, have become established, to provide the wares in demand. Distinguished musical scholars have received musieal instruction in such institutions, though they may not have completed their musical studies in them. In many instances of distinction, it has been found necessary for scholars to be sent abroad. There was no Conservatoire at home where their natural ability would secure for itself gratuitous and thorough training. Hence, in the case of persons without money, this foreign training may have been either impossible or else contingent upon the kindness of a rich friend. *Laisser faire* has been the mainspring of action in respect of musical eultivation and instruction at home. How many talented persons without means or interest have therefore had no chances of cultivating or utilising their special aptitude? Again, how many persons without real talent, but having the pecuniary means necessary, have adopted music as a profession, precisely as they might have adopted the legal or medical profession, or have gone into the ehurch, or the army, or the navy, or the civil service, or eommerce? To eauses sueh as these and to others may be traceable the alleged absenee of musically cultivated people in this country. At the same time, one eannot overlook the faet, that turn where one may, abundanee of the raw material exists of such natural goodness as would insure a return, for public benefit, if means existed for freely giving it the neeessary eultivation.

In England, the oldest, and probably the foremost, of our musieal schools is the Royal Academy of Music. From the latest edition of the published rules, I find that students may choose any branch of music for their principal study, they pay fees for instruetion, and may come and go as they please. This system is, I believe, successful in seeuring for the Aeademy a good income, in addition to the subsidy of £500 a-year it receives from Government. The Royal Academy of Music is in a flourishing condition. The fees are readily paid; there are plenty of persons eager to learn, from term to term, how to play the piano and how to sing. Subscriptions amount to upwards of £540 per annum, and the Royal Academy of Music, as a school available for use by anyone who can pay the necessary fees, and may be required to pass a qualifying examination, is a time-honoured institution of whose continued existence I suppose there need be no apprehensions. But, in spite of this, you see the Royal Academy does not possess the characteristics I referred to of—first, a graduated curriculum of obligatory studies; and, secondly, free admission of proved competent persons to such curriculum of studies. It is therefore different in essential characteristics from foreign State conservatoires.

I now propose briefly to state the sources from which foreign Conservatoires derive their incomes. The Conservatoire at Brussels is a Government establishment supported by funds voted by the Chamber, and by a subsidy from the town and province; foreign students pay fees. At Liége, the Conservatoire is supported by funds granted by the Government, by the munieipality, and by the province. Like the Conservatoire at Brussels, it is under the control of the Minister of Public Instruction. In Prussia, according to a document obtained from the Minister of Public Instruction in 1865, the numerous Prussian Conservatoires are managed by associations, or *vereins*. Occasional grants are made by the State—and they have ehiefly been made—to pay for the training of speeially-gifted persons. This kind of State aid is applicable to any Conservatoire in which properly-regulated courses of instruction are provided. At Leipsie, the Conservatoire is supported by various legacies, subscriptions from the King, and by the fees of students. At Vienna, the Conservatoire derives its income from contributions made out of the Emperor's privy purse, by an annual subscription from the Common Couneil of Vienna, by subscriptions of the society who founded the establishment, and by the fees of a certain number of paying students. Upwards of 100 students of distinction receive free instruetion. At Prague, an association calling itself the "Society for the Promotion of Music in Bohemia," has established and directs the conservatoire of Prague, at whieh all natives who are eligible receive free instruction; foreigners pay fees. The Royal Conservatoire of Munich is under the immediate control of the Minister of Public Instruetion, it derives its income from a State subvention, and from the fees paid by a certain number of students. The Musical Institution at Wurzburg is supported by a subvention from the State and a grant from the academy of Wurzburg; the students are taught gratuitously. The Royal Conservatoire of Music at Milan is wholly maintained by the State, and the instruction is free. The Academy at Naples, called the Real Collegio di Musica, was established on the same footing as that of the conservatoire at Paris. The Royal Musical Institute of Florence is maintained by a grant by the State; the instruction is free. At Paris, the State provides a subsidy for the support of the Conservatoire, and the management of the institution is controlled by the Minister of the Interior; the students do not pay fees. In these cases, then, the payment of a Government subsidy seems to be the principal form of State aid to institutions founded

for the advancement of musical art and public benefit.

In respect to other degrees of State aid to music abroad, I may say, that instruction in music is obligatory in the primary normal schools of France. At the Lyceums, or secondary schools, music is part of the obligatory course of instruction for pupils up to, and including, the fourth class. There are several local conservatoires which are branches of the Conservatoire Nationale. They exist at Lille, Toulouse, Marseilles, Nantes, and elsewhere. The Government makes grants for the support of all these branch Conservatoires, which are under the inspection of an inspector-general—an officer of the Conservatoire Nationale at Paris. In Prussia, singing is part of the course of instruction laid down at the gymnasia and other educational establishments and schools.

State aid to music at home may be divided into two kinds: the first is that of a gift; the second, that of a payment for the fulfilment of certain conditions. Under the character of gifts comes the annual subsidy of £500 given to the Royal Academy of Music, and the subsidy of £250 per annum given to the Royal Academy of Music in Ireland. I have not been able to find any report of the national results which ensue from these gifts of national money, made to the academies above mentioned, which, as recipients of these grants, are classed as "Learned Societies." In respect of payment made on account of the fulfilment of certain conditions, I find that, under Article 19A of the Education Code, managers of elementary day-schools may, under certain conditions of attendance, &c., claim one shilling per child if singing form part of the ordinary course of instruction. It would be interesting to know precisely how many shillings are paid under this article of the Education Code, especially as I am informed, on the best authority, that "singing is taught in all the 20,782 departments of inspected schools in England and Wales." On this basis it would appear that the payments for singing amount to over £96,000 per annum.

An indirect form of State aid to music may be considered to be included in the grants made to the Training Colleges, which supply, to a great extent, the teaching power required in the English elementary day-schools. Where suitable means of instruction exist, instruction in music is part of the general training of the teachers at these colleges. The Government Inspector of Music (Mr. Hullah) in his latest report says:—"Though the quality of the instruction (in music) given in the colleges continues to improve, and the number of students who take advantage of it to increase, I regret having again to record that there is no sensible decrease in the number of those who enter them without any musical skill or science whatever, and that even of those who know something of the art, the accomplishment of the majority is very small indeed." Seeing that in England we have no system of local Conservatoires, as abroad, where persons who are preparing to train as teachers might go through courses of instruction in music, the condition of the musical skill and science, as here mentioned by Mr. Hullah, is perhaps inevitable. But I must here mention an important amendment which the House of Commons made last year in respect of local music schools and classes in Ireland. In the Act to amend the Public Libraries Act for Ireland it is provided that "the terms 'science and art' and 'schools of science and art,' used in the said principal Act, shall be deemed to include the science and art of music, and schools of music respectively; and the council or board of any borough, or the town commissioners of any town shall be at liberty to apply such portion as they may deem fit of the rate which they are or may be authorised to levy, under the provisions of the principal Act, towards the maintenance and support of, and payment of the salaries of teachers of a school or schools of music, and the purchase of musical instruments, books, and other requisites for the use of such school or schools." Such classes, then, will if successfully founded and furnished with qualified teachers, provide Ireland with an instrument of national musical cultivation, with which England and Scotland are not at present supplied.

In respect of drawing, a sister art of music, the Government offers inducements to all kinds of persons in the United Kingdom, whether they are training to become teachers, or whether they are merely educating and instructing themselves, without reference to their future occupations, to study and practice various branches of drawing. Examinations are held annually, prizes and certificates of competency are given, and, under conditions, payment is made on account of each of the successes which students may obtain. This, it will be seen, is a definite payment for an ascertained result. Government also makes payments for ascertained results of instruction in Science. State aid granted in respect of general education is measured by results ascertained by examinations. As regards Music, and grants made in elementary day-schools, Mr. Hullah says that "musical examination in elementary schools would seem to be the natural sequence of musical examination in training colleges." These various facts are perhaps worth considering if means are to be taken to place the status of musical culture of this country on a par with that of the Continent.

The establishment of a national Conservatoire is probably one of the means. It was considered to be so by many persons of authority. The desire to promote the establishment of such a Conservatoire was, I think, the mainspring of the action taken in 1865 by the Society of Arts in regard to musical education. Long before that date, however, the late Prince Consort, who was President not only of this Society, but of the Royal Commission for the Exhibition of 1851, favoured the idea of founding a National School for Music on the estate of the Commission at Kensington. The first thought was to raise up a new school out of the Royal Academy of Music, which at the time I am speaking of (1854) prayed the Commission for the grant of a site on their Kensington estate.

For many years negociations were carried on by the directors of the Academy with the Commissioners. The Society of Arts appointed their committee in 1865, and the first report of that committee contains the following passages, which seem to me to show the importance which the committee attached to making use, if possible, of

antecedent aud existing facts connected with the establishment of a national institution for promoting musical education:—

"The Committee find that in 1854 the Royal Academy of Music made an application to H.M. Commissioners for the Exhibition of 1851, for a site on the Kensington-gore estate, and also for pecuniary assistance towards erecting a building, but that, although a committee presided over by the Prince Consort was appointed by the Commission to consider the matter, no decision respecting it was then arrived at. The Committee venture to think that such an application might be repeated with advantage at the present time, when there is a prospect of the Academy entering upon a more extended sphere of usefulness." Another extract from the same report is as follows:—"To the Royal Academy of Music, which is established under a Royal charter, and at present receives a small annual vote from Parliament, the Committee naturally turned their attention, as being the institution best calculated to serve as the basis for any enlarged national institution for promoting musical education. And the committee had the satisfaction of finding the utmost willingness on the part of the Royal Academy to adopt whatever course might be necessary to improve its organisation, and render it thoroughly efficient." After the publication of this report the movement in the matter appears to have ceased, and it is not until some four or five years later that there are any outward signs of establishing a National School for music, in accordance with the precedents and experience furnished by foreign State-aided conservatoires. We then find the Society of Arts' Committee at work once more at the subject, and at length a Provisional Committee of Management is appointed, in which are represented the interests of those who have been trying for so many years to establish a national institution for music. This committee was presided over by H.R.H. the Duke of Edinburgh, and consisted of two members representing her Majesty's Commissioners for the Exhibition of 1851, two members representing the Corporation of the Royal Albert-hall, and three members from the Society of Arts. The particular part which each of these bodies plays in the creation of the National Training School for Music may be thus stated. The Society of Arts indicated the scheme on which the school was to be modelled, and undertook the movement for collecting funds for scholarships, and in making the scheme generally known. Moreover, to H.R.H. the Prince of Wales, President of the Society, was the building munificently presented, as a free gift to the nation, by Mr. Charles J. Freake, at the meeting held at Marlborough-house on the 9th of July, 1875. Her Majesty's Commissioners, as the projectors of the establishment of a school for music on a national basis, have provided the site, near the Albert-hall, on which this building stands; and the Corporation of the Albert-hall lend certain rooms, and a theatre in the hall, for the use of the students. On the 18th of December, 1873, the first stone of the building for this new institution was laid by H.R.H. the Duke of Edinburgh. Mr. Freake had generously undertaken to cause the building to be erected. On this occasion, H.R.H. the Duke of Edinburgh referred to the original idea, that the Royal Academy of Music might serve as the basis for the National Training School for Music, and said:—

"There was a pause in the labours of the Society of Arts, and those labours have now [1873] extended over about 15 years; but there was another pause, which occurred at my own suggestion, on account of a thought on my part that the two institutions might have been united into one. I myself undertook negociations with the Royal Academy of Music, with that view; but, after some considerable time had been spent in them, we found that the principles on which the two institutions were founded were so far apart, that it was not advisable that they should be united into one. The Royal Academy has but few free scholarships for those who have displayed a knowledge and aptitude, but have not means; the fundamental principle of the school we are assembled this evening to celebrate the foundation of, is the free scholarships for all ranks of society."

In remarking upon the difference of constitution which exists between foreign Conservatoires and our Royal Academy of Music, it may be remembered that I called especial attention to what I think are the essential features of a musical Conservatoire, viz., first, a graduated curriculum of obligatory studies; and second, the free giving of such instruction to proved competent natives of the country in which the Conservatoire is established. How far the constitution of the National Training School for Music provides for a compliance with these two essential requisites may be seen by any one who will consult the directory of the school. It is there stated, paragraph 3, that "the fundamental principle and primary object of the school is the cultivation of the highest musical talent in the country, in whatever station of society it may be found. In order to carry out this principle to the fullest extent, admission to the school can be obtained by competitive examination only;" and in paragraph 23 it is expressly laid down that "Admission, as a student, cannot be obtained by merely paying fees." The school derives its income from the scholarships founded by corporations, individuals, and localities. Each scholarship is founded for five years, and is of the annual value of £40. The holders of them receive free instruction at the school. The conditions which attach to the gaining of a scholarship, and to the subsequent holding of it, are primarily based upon the possession by the candidate of musical ability.

When the school was formally opened in 1876 there were about fifty scholars. There are now upwards of eighty-eight scholars, whose scholarships yield an income to the school of about £3,500. For the complete development of the school, it is hoped that 300 scholarships may be permanently founded and held by 300 students in the school. In Paris there are now 550 regular students, and the Government subsidy for supporting the conservatoire amounts to 214,000 francs (about £8,560). Besides this, the French Government makes to certain selected scholars maintenance grants, which amount to 24,000 francs a year. At Vienna there are upwards of 300 students, 106 of whom pay no fees. The income amounts to about £3,200. At Liége there are upwards of 300 students, and the income of the Conservatoire amounts to about 160,000 francs, say £5,400. The hope, then, that the National Training School for Music may instruct and educate 300 scholars cannot, therefore, appear to be chimerical.

When a guarantee or promise of a good return can be offered, it may be permissible to suggest a direction to strengthen the action of the *laisser faire* principle, on which the cultivation of an art may depend. In respect of the science and art of music, the Society of Arts suggested the combination of efforts to promote the founding of scholarships. The goodness of the results of the National Training School for Music is, I have every reason to know, jealously protected by a strict administration of the rules and regulations to be observed by scholars. Rule No. 4 is worth quoting as an example of the precautions adopted to insure a success in respect of the efficient training of a student. It is this:—"The total period of instruction will extend over from three to five years, and all scholars will be required to sign an agreement to work out the curriculum of study appointed by the professional authorities of the school, and to obey the rules." It is hardly within the scope of my paper to touch upon points affecting methods of instruction, or of what courses of instruction shall consist for (say) teachers of elementary day schools, other teachers, and for *artistes*. Those, I imagine, are purely technical questions to be settled by professional men. I can imagine that without infringing a principle of the school's constitution—viz., free instruction to persons of ability—it might be advisable to encourage School Boards, Training Colleges, and such like institutions to pay fees for the instruction, at Kensington, of qualified students whose object in life is to become teachers of elementary music. The admission of fee-paying students of this kind would probably assist in developing the character of the National Training School as a National Conservatoire. It would be a way of promoting one of the objects of the school, namely, to be the centre whence may be drawn a large proportion of the teachers, to whom the country must look for the instruction of its young. There is an ample supply of music schools for fee-paying amateurs. The National Training School for Music is founded to meet wants other than those of fee-paying amateurs. To quote from the Directory of the School, "It occupies a field of action wholly distinct from that of any other existing institution" of this country.

As many are well aware, the professional administration of the National Training School is conducted by the principal, Dr. Arthur Sullivan, and a Board of five principal professors, consisting of himself, M. Ernst Pauer, Dr. Stainer, M. Alberto Visetti, and Mr. Carrodus. There are in addition twelve other professors, ladies and gentlemen of professional eminence. The professional examiners are Sir Michael Costa, Sir Julius Benedict, Sir George Elvey, Professor Ella, Mr. Charles Hallé, and Mr. John Hullah, Her Majesty's Inspector of Schools for Music. It must be admitted that this is a distinguished staff of professors, and is, I venture to believe, an indication of the general confidence of the profession in the liberal principles upon which the school has been founded for the prosecution of its purpose.

In June, 1863, the Lords Commissioners of her Majesty's Treasury, in a communication addressed to the Chairman of the Directors of the Royal Academy of Music, stated in regard to the possible application of State aid in this country to the promotion of music, that "they will deem it necessary to be assured, by sufficient proof, that the institution, which may claim to be the immediate recipient of aid, is not only one entitled to acknowledgments for past services, but is also in possession of the general confidence of the profession, and is constituted in the most effective manner, and on the most liberal principles for the prosecution of its purposes; or else is engaged in adopting such measures as may entitle it to claim to correspond with this description."

Whenever the time arrives for considering the giving of State aid to music under the conditions set forth in the letter I have just quoted, I hope that the facts I have been able to collect may be of some service.

In conclusion, I may, perhaps, repeat that the scholarships founded through the agency of the Society of Arts are, for the most part, established for five years. During that term, and according to the conditions of the experiment, thus favourably started and developing, it is to be hoped that the national confidence in the institution will become more and more firmly rooted, so as to lead to the realisation of the Society's "confident hope, that the school will eventually be transferred to the responsible management of the State."

DISCUSSION.

Mr. Gruneisen said he had been requested by Professor Ella to say a few words on the subject. It was now upwards of 40 years since he first started thoroughly the idea of founding a national Conservatoire in this country on the basis of a State grant, and he had the honour of an interview with the then Premier, Sir Robert Peel, to whom he stated the reasons which had prompted him to lay the matter before the Government. Sir Robert Peel said he personally had every desire that a national Conservatoire should be founded in this country and supported by the State, but that, as first minister of the country, he could not take the initiative in the matter, the movement must commence by pressure from without; and he said that unless the country could be got to call for the establishment of such an institution, it would be hopeless for the Chancellor of the Exchequer to propose in the Budget a vote of sufficient money for the purpose. Lord Westmoreland had endeavoured to carry out his primary intention, in founding the Royal Academy of Music, of obtaining for it State aid, but with all his personal influence with her Majesty he was unable to achieve the object he desired. There had been a very great change as regarded the question in this country; whereas 40 years since the cultivation of music depended on the patronage of a few noblemen and gentlemen, it had now become a general study, had already penetrated to the middle classes, and it was to be hoped would, in the future, extend to the lower classes, so that the whole community would enjoy its humanising and civilising influence. He had, himself, inspected the continental establishments which had been referred to in the paper as existing in France, Italy, and Germany. No doubt the meeting was aware that every dukedom and small principality which formerly existed in those countries had had its own Conservatoire or theatre which was supported by the State, and those establishments now received aid from the municipalities of Munich, Stuttgard, and other large towns where they existed. The French Government lost no less than £40,000 a year in supporting the National Opera House in Paris, but in Belgium a better state of things was found, for the king, though not a very enthusiastic musical amateur, took a statesmanlike view of the question, and did all he

could to support the Conservatoire at Brussels, which had for its head a very able man—Professor Gaimart. In Belgium, and also in France, not only did the State give support to these Conservatoires, but the municipalities, as, for instance, in Ghent and other large towns, assisted by their votes in their support; so that the *vox populi* was freely given there in support of the cultivation of music. We had not arrived yet in this country at that condition of things, but we were progressing, and we should be very glad to see followed the example set by the paper of taking the broad view of the support of music as an art by the State. If the matter were properly taken up, success would in due time follow their endeavours. But it would probably be a very slow work, because they had seen, only the other evening, when the Premier was called upon for a vote of supply for the defence of one of our most important seaports, the poverty of our finances was pleaded against it; and how would the Chancellor of the Exchequer have any chance of success in proposing to the House of Commons a vote for the support of a Conservatoire of music? It had been urged against these Government grants that they had not been the means of producing Handels, Mozarts, Beethovens, and others of the great geniuses and masters of the art of music, who had produced works for which the world was indebted; but still a great deal had been done by the Academy of Music in supporting well-instructed professors who had done much for art, even if it had not entirely carried out all the intentions of its founders and promoters.

Mr. Christian Mast feared that an erroneous impression might be conveyed by the paper, inasmuch as it might appear that music in continental countries was promoted principally by the State. He did not deny for a moment anything that had been stated, but wished to direct attention to the fact that a portion of the music in Germany resulted as much from the movement of the people as from the Government. The Germans were a music-loving people, and State aid was only subsidiary to the efforts of the people themselves. It was a great mistake to think that because Germany was well governed and almost everything was done by the Government, that art also was promoted by it. Their great poet Schiller expressed it most beautifully that art, even at the throne of the Great Frederick, had to go without assistance. With regard specially to the *modus operandi* of the cultivation of music in Germany, he would say that singing, although supported by the State, had been mainly developed by the numerous singing societies. When he was in Germany, he was always a member of one singing society or another, and those societies did everything for themselves, and would have been ashamed to ask Government for support. Another point was this, every town used to have its town musician. He was a native of a town of only 300 inhabitants, but, when he was young, they always had a town musician who instructed people gratis. He had no subsidy from the State, but was paid by the town, and it was his duty to instruct any son of a citizen gratis in any instrument he liked. He was bound to conduct some musical performance in church every Sunday, in which his pupils took part. He was sorry to say that this old custom was beginning to die out, but it had left behind such an influence as it would take a long time to displace, and he was glad to hear that in some towns, where the custom had been abolished, it was being revived.

Professor Monk, being not only deeply interested in this general question, but professionally connected with the training school at Kensington, of which mention had been made, said he would offer one or two remarks on the present position of the institution, and on what seemed to him to be the probable result of the system under which it had been established. As regarded the permanent maintenance, both of it and its students, nothing had been said, except quite incidentally, as to the way in which students were to be maintained at such a Conservatoire as was advocated. The school at Kensington derived its only income from the funds provided by those liberal corporations or persons who founded scholarships. Mr. Cole had mentioned what the income was, and they had at present about 90 students, who were elected from all parts of the country. Those interested in the matter ought to see the little book published as the "Directory" of the school. These students, having been elected from a very wide circuit, came up to London for their education. He would say nothing as to the character of that education, but he could bear witness, in part, to what had been up to the present moment the great diligence of the students, and to some very valuable results. It could not be expected that—especially at the beginning—every election would bear the fruit that might be hoped, but they had a very fair proportion of students who were likely not only to pass through their course with credit, but to the public benefit as musicians. He had not the honour to be in any way connected with the management of the school, being only one of the professors, but he saw all the students, and was to some extent acquainted with them, and what struck him with regard to the permanent usefulness of such an institution was this—that unless they could eventually derive a very substantial benefit from State aid, the difficulty of carrying on such a Conservatoire would be the maintenance of most of the students at a distance from their homes. These young people, many of them of very tender age, were placed at a great distance from their families, and had, of course, to be provided for. With regard to the younger students, unless their parents could afford to keep them in London during their course, they must eventually retire, and there had been one or two instances of this already. With regard to those rather older—say, between 18 and 22—many of them were thrown upon their own resources for support, partially, if not entirely, and he knew that many were at this time working very hard at teaching in order to keep at the institution. This was a necessity under present circumstances, but it acted very prejudicially in more than one way on their professional training. In the first place, time, which was everything to a young person during such a course of study, was partly spent, not in the studies they came to prosecute, but in the ignoble endeavour to support themselves. They all knew what London was, and what professional life meant, and how much of the time of a hard-worked professor was occupied in getting from one place to another. These young students had, of course, equally to combat the geographical as well as the financial difficulties of living in London, and he thought they could not too strongly make use of these circumstances, though the present was an unhappy time to think of it, in urging upon Government the necessity of providing such means as would enable students of this kind to come to their studies, unembarassed by the necessity of getting a living. It appeared to him that this could only be properly accomplished by the expenses of such an institution being provided for entirely by Government. What was £3,000 or £6,000, or even three times as much, to be spent on an institution which would really do its work to the Government of a country like this, in which we have at a few days' notice half-a-dozen millions voted for problematical war expenditure, and 60 or 600 millions if wanted for the same purpose? By and bye it would become the friends of musical education to press the Government for such a provision as this, in order that the students, wherever they might belong, might be able to live out of the scholarships offered them for competition. It appeared to him that this should be the direction in which the money given by their liberal friends all over the country should go, namely, to sustain the students, and that the technical expenses of the school should be derived from the State.

The Chairman, in proposing a vote of thanks to the

reader for his very able paper, said Mr. Cole had tried to show them by the example of what was done in foreign countries, that they ought to do something more for their own in giving State aid to the cultivation of music. He agreed with one of the previous speakers that the Chancellor of the Exchequer would probably not acknowledge the force of that argument, and might possibly say that the ways of foreigners are not our ways; that our way was to do without State aid, and, if he were holding an argument with the speaker, he would probably say that there was a time when the knowledge of music was much more widely spread in England than now, when no State aid was given to its cultivation. It was stated in the diaries of olden times that music was so universally spread among all classes that it was very common, when people had musical entertainments, for them to call in their servants to assist; and it was also said that when they hired their servants they informed themselves of the quality of their voices, in order that they might be capable of doing so. He did not know whether it would be suggested that they should add that burden to their present difficulties in obtaining servants, as, for instance by insisting that footmen, besides being six feet high and well developed in the calves, should have tenor voices, or that the cooks should be good contraltos. That was not very likely to come to pass at the present day. But he did not think the most penurious Chancellor of the Exchequer would deny the advantage of having the knowledge of music most widely spread; there could be no doubt that among the branches of education undertaken in our national schools music might be made an important feature, and he should be very glad to see the subjects of education revised with that view. No doubt the extra subjects, as they were called in the Code of education, such as foreign languages, geology, and other sciences, might have music added to them, with more benefit to the people concerned; and it would give more pleasure than almost any of the others, because music was an art which could be enjoyed not only by the persons who practised it, but by other people too. There was the advantage also in the cultivation of music, that, like every other art which cultivates the mind, it gives people occupation, which they were often in want of; and, if a knowledge of music were more generally diffused among the lower classes, it would furnish them with a more beneficial way of passing their time than by spending it in public-houses. Nobody, therefore, could deny the advantage of promoting the knowledge of music. Though he was himself in favour of doing things by private enterprise, there was the strong argument in favour of State aid being given to the cultivation of music, that there was already no branch of education in which the teachers were not supported by something amounting to State aid. To take the instance of our Universities, though not maintained by State aid, they were supported by sums contributed in former times by private individuals. It might be said, why not allow private individuals to contribute towards the support of musical colleges? but it must be remembered that those large Universities had taken many hundreds of years to arrive at their present condition, and they were not going to wait hundreds of years, if they could help it, for the establishment of colleges of music. He, therefore, hoped the meeting would join in wishing success to the views advocated by the lecturer, to whom he had great pleasure in proposing a vote of thanks for his able paper.

Mr. Cole, in acknowledging the vote of thanks, said one or two remarks had been made about the State support given to continental Conservatoires of music not being in accordance with our English ideas. Our National Training School for Music had been entirely started by private enterprise, and had not been dependent in any way on Government aid at present, and they could only look forward to the time when they could show Government that they were worthy of receiving State support as a kind of supplemental support to that which they received from private enterprise. The Government at present spent £96,000 a-year in promoting singing in elementary schools, and it was no doubt a very proper expenditure. Whether the time would ever come when they would receive aid from the Government for the schools of music, he could not say, but at all events, a combination of State aid, and assistance from private enterprise, was a desirable result to look forward to.

MISCELLANEOUS.

ELEMENTARY SCHOOLS.

Extracts from Reports of H.M. Inspectors of Schools for 1876-7.

There being no digest or index to the Annual Education Reports, the following abstracts from the Inspectors' reports have been made. The subjects taken are those which the Society is actively promoting. They will be found generally useful, and suggest the desirability of future Reports of the Education Department being furnished with an index.

I.—Domestic Economy.

A favourite subject.—Rev. H. G. Alington, 394.

Desirable to be learnt as an extra subject.—Matthew Arnold, 402.

Sufficient care not taken in teaching elementary principles before proceeding to details.—Rev. J. G. C. Fussell, 485.

Of the utmost importance for girls, who, by a wise regulation, will be obliged to learn domestic economy if any specific subject is taken.—H. E. Oakeley, 519.

II.—Cookery.

Arrangements have been made at the British School at Milford, near Derby, for giving instruction in cookery which is apparently well carried out. When instruction in cooking can be combined with school work, beneficial results will be produced, provided there is a determination on the part of the managers of a school to make instruction in the subject a reality.—Rev. J. J. Blandford, 432.

Experiment in giving instruction in cookery tried by the Sheffield Board seems likely to answer admirably. —Rev. H. R. Sandford, 560.

Time allowed for instruction of girls in practical cookery not been taken advantage of in a single case.— C. E. Vertue, 610.

III.—Buildings.

Improved lately by addition of class-rooms, or introduction of glass windows into class-room, walls, or doors.—E. H. R. Rice-Wiggin, 549.

Old buildings often in bad repair, with ill-fenced playgrounds and imperfect drainage; new, usually costly, spacious, with good lavatories, and an ample water supply, but they are frequently defective in ventilation and light.—H. Waddington, 612.

Thirteen out of twenty-three School Boards have already erected or provided their required buildings. Eleven schools in course of erection or adaptation. Commencement of necessary work been obstructed by difficulties arising out of questions of site, title, or local jealousies.—Rev. W. Warburton, 626.

Those erected by School Boards generally handsome, and well arranged, butnot damp-proof.—Rev. E. T. Watts, 640.

IV.—Ventilation.

Managers and teachers too often not sufficiently aware of its importance.—W. Baily, 407.

Ventilation not properly attended to.—R. F. Boyle, 438.

Always a difficulty, the so-called vertical system answers in many respects very well.—H, F. Codd, 462.

Almost invariably imperfect.—Rev. C. F. Johnstone, 503.

Wishes managers could be brought to realise, there is no necessary connection between ventilation and draughts. —E. H. R. Rice-Wiggin, 542.

Good ventilation depends in many schools on keeping the windows or a trap door in the roof open even in bitter weather; the simple plan advocated by Mr. Tobin in the *Times* is in use in Thursley National School, and answers admirably.—C. E. Vertue, 598.

Often the ingress of fresh air not provided for; an excellent plan for ingress ventilalion is to have openings in the outside wall under a window, some 18 inches from the ground, running up through the wall into the inner window-sill; the internal opening should be fitted with a small movable shutter opening upwards on stiff hinges fixed on the *inner* side; the draught is thus thrown upwards above the heads of the pupils.—H. Waddington, 613.

V.—Warming.

Warming schools not sufficiently attended to; an absurdly small sum spent on fuel; this expense is generally stinted.—R. F. Boyle, 438.

VI.—Needlework.

Only in a few cases well done, partly from home instruction being bad, and partly from inefficiency of teaching from certificated mistresses.—Rev. C. F. Johnstone, 505.

Desirable to adopt a fairly easy standard, and to expect good work to that extent.—H. E. Oakeley, 516.

The Education Department should issue an authoritative scheme for needlowork, and instead of the specimens being examined by inspector, they should be sent to the office of the Department, and there submitted to some competent authority, whose remarks should be appended to report of inspector. Girls are often set to do work not suited to their skill or advancement; darning often foclishly shirked. Sewing should be required for a labour test.—Rev. C. H. Parez, 531.

Fairly satisfactory; relieved from trouble of marking the specimens by wife, whose correctness of judgment on such a subject better than own.—E. H. R. Rice-Wiggin, 549.

Great improvement in needlework under new Code; the adoption of a regular plan has caused the subject to be taught methodically, which was rarely the case before.—Rev. H. R. Sandford, 555.

An important part of a girl's training.—Rev. H. Smith, 567.

Most useful to teach girls, in the way of sewing, how to patch and darn their clothes; making their garments of far less importance.—Rev. G. Steele, 576.

Desirable that mistresses should, at intervals, hold sewing examinations, on the same plan as inspectors.—H. Waddington, 618.

A subject of primary importance to girls; a visible improvement apparent in the sewing of several schools. A difficulty often experienced in obtaining a competent person to teach in mixed schools under a master.—W. Williams, 650.

Examination in needlework a success; it will be improved by system in teaching; where already well taught the recognition of its claims will be an encouragement. No difficulty in carrying out the examination except in respect of really testing the power to cut out. —Rev. H. G. Alington, 392.

Female help required for proper award of new grant; men not fit judges as to plan of teaching needlework, or of results of examination in it.—M. Arnold, 400.

Desirable that the Code should declare what course of instruction should be pursued.—W. Baily, 413.

Male inspector deficient in qualifications for systematic examination in needlework; consider that a fresh field of official employment must be opened to feminine energy and tact, and that the appointment of skilled seamstresses as examiners is desirable. Need be no difficulty in holding central examinations, in towns to which children or classes from particular schools might be summoned by the needlework examiner to undergo the requisite test; such central examinations might afford an opportunity of more thoroughly testing skill of pupil-teachers in needlework and cutting out than is possible at present. Consider it would be better to classify needlework solely with reference to actual proficiency in it, and not as regards pupils' advance in the standards of tho Code.—J. P. Balmer, 425, 426.

Method of examination moro successful under the present Code. Arranged scheme of needlework for next examination, with assistance of ladies.—R. F. Boyle, 442.

Improved, especially as far as knitting is concerned, but not satisfactory; this useful part of instruction demands better skilled examination to appraise, speaking in the mildest words, its money value.—Rev. W. Campbell, 449.

Number of failures in needlework comparatively small. Needlework a strong point in country schools, who compare favourably with large town schools, perhaps in some measuro due to the interest ladies take in the work of these small parish schools, which is wanting in Board schools in large towns.—H. F. Codd, 458, 459.

Combats the notion of many ladies, who declare that "the educational movement of our generation has quite put an end to all good needlework."—Rev. C. D. Du Port, 473.

With few exceptions sufficiently good to pass; a ready and intelligent use of the black-board invaluable in teaching this subject to a class. Knitting been taken up, even in infant schools, with astonishing eagerness and success.—Rev. F. G. C. Fussell, 484.

VII.—Arithmetic.

One quarter of the children failed in arithmetic Teaching of mental arithmetic desirable; black-board teaching important; girls inferior to boys in arithmetic, probably from less thorough teaching.—H. E. Oakeley, 515.

Weak; particularly poor among female pupil-teachers. —Rev. C. H. Parez, 532.

Worse results than ever; failures traceable to radically imperfect teaching.—E. H. R. Rice-Wiggin, 548.

The most mechanical and unintelligent methods often followed, even at schools where accurate results are obtained; teaching too much left in the hands of pupil-teachers.—Rev. H. R. Sandford, 559.

Elementary education should aim at teaching such simple calculations as will be wanted in buying necessaries and selling one's labour.—Rev. H. Smith, 568.

Far more children fail in arithmetic than in other subjects. Copying from each other a fruitful source of failure and disappointment.—Rev. G. Steele, 587.

Routine work, notation, and plain rules fairly done, but application of the rules to simple problems still far from satisfactory. These remarks do not apply to all schools in my district, for good arithmetic teaching, in some of them, has taught the children to think and to think rapidly.—Rev. F. Synge, 593.

Well and intelligently taught in some schools, but very defective generally. The want of proper precautions being taken to prevent copying during the year accounts for a large number of failures at the inspection.—C. E. Vertue, 605.

A great stumbling block, taught mechanically by rule,

without intelligence, without anything but a parrot-like repetition of formulæ.—H. Waddington, 617.

Results far from satisfactory.—Rev. W. Warburton, 628.

Cannot speak favourably of the teaching of arithmetic, fear there is a want of system and continuity in it; children not sufficiently grounded on the black-board in the principles of the subject.—W. Williams, 649.

Poor results; subject badly taught in many cases.—Rev. H. G. Alington, 389.

Improvement in this subject; work done more accurate, and neater in arrangement; subtraction less successfully taught than other simple rules.—Mr. Sedgwick, Inspector's Assistant, 418.

Much time in teaching frequently lost through the mistaken notion that the standards are a sufficient chart for the instructor as well as for the examiner. Requirements of Code too often regarded as a maximum. Modification of arithmetic standards introduced in last Code to be regretted.—J. P. Balmer, 423.

Improvement, particularly in the lower standards; seems worked with greater accuracy and quickness; in the upper standards, questions requiring some degree of thought have been more frequently solved.—Rev. J. J. Blandford, 431.

Improvement shown in arithmetic; boys, as a rule, work sums more rapidly and correctly than girls.—R. F. Boyle, 440.

Weaker results than in all other subjects of school work. First cause of failure is imperfect teaching of notation, generally relegated to the youngest teachers.—Rev. W. Campbell, 447.

Failures in arithmetic due to scarcity of good teachers in it. Children generally take an interest in it, and considering that mere mechanical accuracy, with a minimum of intelligence, is sufficient to ensure a pass, the number of passes ought to be greater.—H. F. Codd, 457.

Results of teaching, on the whole, fair.—Rev. J. G. C. Fussell, 484.

Better teaching required.—J. B. Haslam, 501.

Seems beyond the comprehension of the rural mind. Never, except in rare instances, mastered.—Rev. C. F. Johnstone, 505.

VIII.—Music.

Very unsatisfactory; very exceptional to find singing of any individual boy or girl striking; voices naturally harsh. In greater part of schools no attempt to teach except by ear, and in chorus.—R. F. Boyle, 443.

Materially deteriorated within the last three years.—Rev. W. Campbell, 449.

Singing generally taught; results fairly good, and worth the money expended. Singing by note exceptional; value of mere singing by ear not to be depreciated, the children like it; it is valuable as a discipline, is humanising, is in fact the one bit of their teaching which appeals to their taste.—H. F. Codd, 459.

Very few schools in which it is not taught at all; consider it beneficial to the children.—Rev. C. H. Parez, 535.

Singing improved, and taught from notes in a large number of schools. Music papers worked by pupil teachers at monthly examinations do not improve. Recommend that harmonium should be sparingly used; it covers defects, but does not encourage self-reliance on the part of children.—Rev. H. Smith, 569.

Music, certainly to a great extent, *nascitur non fit*; palpably hopeless for a teacher without ear to teach it to much purpose. Tonic sol-fa system good for teaching practical music quickly, easily, and pleasantly to the masses.—H. Waddington, 861.

Music not commonly taught in elementary schools; singing from notes altogether an exceptional subject; the songs, for the last few years required of scholars, not merely worthless as musical culture, but take up time that might be given to real study of the subject. Music is the single subject in which our future school teachers are prepared at considerable expenditure of time and money, the results of the teaching of which are neither ascertained with any precision nor recorded.—J. Hullah, 730.

IX.—Drill.

The number of schools in which military drill is taught is at present very small; might be increased with great advantage to all concerned.—H. F. Codd, 459.

More or less regularly taught in the Board Schools; not introduced generally in other schools.—Rev. J. G. C. Fussell, 489.

Desirable that pupil-teachers should take part in drill; exercise advantageous to them.—Rev. C. H. Parez, 535.

Good effect on the discipline.—Rev. H. R. Sandford, 555.

Not generally taught; deserves more attention; it is an excellent thing for boys.—H. Waddington, 618.

PARIS EXHIBITION.

[From a Correspondent.]

When last I had the pleasure of writing to the *Journal*, in October, the main work of the buildings of the exhibition were approaching termination, now the same is true of the whole work, decoration included, and a certain portion of the fittings are in place. The public is now excluded from every part of the ground devoted to the exhibition, and the tramway cars and all other vehicles run through the cuttings made for that purpose in the quays on each side of the river; the bridge of Jena is being covered with a wooden platform supported upon east iron girders, which rest on short columns just over the heights of the parapets, the platform and girders extending about sixteen feet over the parapet on each side; there will be handsome iron rails at the sides, and a single line of rails in the middle for passenger cars, so that the visitors to the exhibition will have a fine broad way between the Champ de Mars and the Trocadéro; the necessity for such a width is not apparent, except on the supposition that the bridge was to be treated as a part of the exhibition, and fitted with shops, or counters, somewhat after the manner of the Rialto at Venice. In consequence of the bridge of Jena being included within the limits of the exhibition, a foot-bridge is being erected a little higher up the river, where there is an island in the midst of the stream. This new bridge is only for foot-passengers, and consists of a wooden platform laid upon large iron tubes sunk in the river in pairs, and filled with concrete. The tube-piers are finished on one side, and part of the platform is laid; the whole will be finished very shortly.

The entire site of the exhibition is now being surrounded by wooden palings, which are said to extend to six miles. Starting from the river a little above the bridge of Jena, they rise to the top of the Trocadéro, then descend on the other side to the river again, recommence at the opposite point, take in the whole of the Champ de Mars, the whole of the quai d'Orsay to the esplanade of the Invalides, about a third of of which is devoted to the shows of live cattle, horses, and other animals, and terminate again on the quay. The fence is a common fence of deal, with spaces between the slips, which are about six inches wide; but it is high, about nine feet, and its cost will be four thousand four hundred pounds.

One of the main galleries of the building on the Champ de Mars attracts special attention, and it will certainly be the fashionable lounge of the exhibition; this is the grand vestibule facing the river. The central dome is just finished, the grand flight of steps which lead from the garden is nearly so, and the façade is being decorated with shields bearing the arms of all the exhibiting nations, and over each will wave the national

flag. The application of this grand vestibule, sixteen hundred feet long, be it remembered, eighty or more feet wide, and very lofty, is in my opinion most happy. Opposite the central entrance will be an enormous bed of flowers, which is to be maintained during the time of the exhibition by the Belgian Horticultural Society, under the direction of M. Linden, one of the most celebrated horticulturists in Europe, who promises that the show shall be the best within his power. On each side of this floral trophy will be shown some of the choicest products of Europe and Asia. On the left hand on entering, the French Commission will exhibit some of the rarest gems of their manufacturing skill; on the right will be a selection from the riches of India. The vestibule is to be treated in a purely decorative manner, the walls will be covered with the most exquisite products of the loom, while the other articles will be arranged in the most effective manner, but so as to leave a great space for the company. The iron work above is hidden by an admirable ceiling, in plaster or *carton pierre*. The whole of the upper portion of the building is of glass, on both sides, so that there will be all the light that can possibly be desired, and there can be no doubt that this vestibule will be the most splendid and effective ever seen. On the French side one large decorative case is already remarkable; it is to hold the State jewels.

The cross gallery, or vestibule at the other end, will also be highly attractive; in it are to be shown all the processes of manufacture exhibited. And while all nations, I believe, will contribute to it, it is said that almost every one of the trades, especially Parisian, will be more or less illustrated; processes are attractive to almost everybody, and the second vestibule will probably prove a dangerous rival of the first in popular favour.

In the grounds an endless number of additional buildings have sprung up, and the most remarkable of them is the French machinery annexe, which extends the entire length of the Champ de Mars, with the exception that it is broken in two by an entrance door, the Porte Rapp, and the offices of the Commission, juries, &c., but the whole are brought into communication by means of an immense glazed roof or marquise, which will be very acceptable on wet days. The buildings themselves are partly of wood and partly of iron, light and elegant, with graceful roofs covered with galvanised iron tiles. The next most important building on the French side is that of the great Creusot works, a large structure of solid stone; amongst other buildings is one for making artificial ice on a large scale. On the foreign side, the largest building is the British annexe, which skirts the ground just opposite the English machinery gallery, near this is a restaurant, and at the further end is a large building, which is said to be for an English beer-house, but I have not inquired whether this is the fact.

The arrangements for the supply of the exhibition with water are, perhaps, as striking as any part of the undertaking, and I will give an outline of the whole in a few lines. Behind the Trocadéro building, where the boulevard is 90 ft., or thereabouts, above the quay, an enormous basin—formed of the fine Jura stone, polished—has been established. This basin is 160 ft. in diameter, and 6 ft. deep. It will receive the water of the Seine, raised by the 400 horse-power pumps erected on the bank of the river, and also all the overflow of the two immense reservoirs which now supply Paris with the excellent water of two or more streams, brought to the capital in conduits. In this basin—which, I should say, is surrounded by large flower-beds and trees, recently planted—is some rockwork, from which will spring a grand sheaf of jets, the most effective fountain yet designed; for this purpose there are three different-sized pipes, so as to produce jets of different size and force. From the basin the water will flow down beneath the *grande salle*, and fall down the great cascade into another fine basin in the garden, which also has its fountains. The Champ de Mars is supplied by three pipes laid across the bridge of Jena, beneath the wooden platform described above.

On the inner side of the foreign division the architectural façades are some of them finished exteriorly, and all in progress, but I prefer speaking more particularly of them on another occasion. At present, I propose to say a few words concerning the exhibition in relation to the arts, sciences, and public works.

In the enclosed garden and occupying the central place is a large pavilion, in which the municipal authorities of Paris will exhibit all that appertains to the public services of the city, educational, charitable, and other institutions, models, relief maps, charts, statistics, documents, and other illustrations, and around it will be a grand show of flowers and shrubs from the glass-houses at Passy, where at the present moment, I may mention, two Japanese are occupied daily with the collection which has been sent over from their own country. The Paris authorities have surprised almost everybody by the beauty and novelty of the pavilion in which this municipal material is to be shown; it is nearly all of iron, and the decoration is of a most elaborate and costly kind, namely, pierced saw work; the designs are charming, and the relief obtained by the use of various coloured materials, and the introduction of engraving here and there, adds greatly to the effect. It will be remembered that some beautiful examples of pierced metal work were exhibited by a Parisian house at the South Kensington Exhibition of 1871 or 1872, but nothing of the kind or so grand a scale has ever before been attempted. At the first International Exhibition held in Paris, the band or ribbon saw, though not positively new, was first produced in a practical form, and ever since that time pierced work has been much in favour; such work as this to which I am referring cannot, however, be executed by means of the band except on certain conditions, that is to say where the pierced panels are set in frames, &c., so that the continuous saw may cut its way without disfiguring the work, but in the present instance most, if not all, of the work must have been produced by the reciprocating fret saw, for the patterns are intricate and offer no such openings as are above referred to.

The Minister of the Interior will also make an exhibition of a character very similar to that of the City of Paris; it will include, amongst other things, models and drawings of the best constructions for schools of three types; the first for small communes, the second for one of three thousand inhabitants, and the third for large towns, with full particulars as to cost, &c.; the same in relation to small hospitals and *maisons de secours* for places where there are no hospitals. In addition to these, the methods and materials for supplying communes with water, gas, or other illumination; the systems of sewage and utilisation of sewage water, and all the means employed for the maintenance of roads and pathways; the statistics of all the existing means of public assistance, whether public or private, and of all institutions for the moral or physical benefit of the working classes, whether established by employers or by workmen themselves; and, lastly, a collection of plans, charts, views, models, casts, relief maps, and heliographs of all the oldest and most curious artistic decorations, &c.

The French Association for the Encouragement of Science will naturally take advantage of the assemblage in Paris to further its views; the Council of the Association has determined to hold a special session in Paris, to be inaugurated on the 16th of August, under the presidency of M. Frémy. One object of this society is the assistance of young scientific men; sums amounting to nearly nine thousand francs were voted at the last meeting of the Council, and a number of wealthy persons have placed important sums at the disposal of the Council for the same purpose. A special and important local committee is about to be formed comprising all the leading scientific men of Paris, and including a

number of wealthy persons zealous in the cause of science.

The last subject I shall touch upon to-day is music. The Commission has published the outline programme for the season of the exhibition; there are to be in the Grande Salle des Fêtes ten concerts with full orchestra, solo singers, and chorus, twelve organ concerts, four meetings of choral societies, and four devoted to military music. In the Salles des Conferences, five rooms on the upper floor, capable of holding five hundred persons each, there are to be sixteen chamber concerts, and a number of concerts of "popular and picturesque music," not yet determined. The Commission for the grand concerts will select the most remarkable works of French composers produced since 1830, and they will be performed by 150 musicians, a chorus of 200 voices, and certain societies of chamber music.

In addition to all the official concerts and musical meetings, the Grande Salle, as well as the Salles des Conferences, will be placed at the disposal of musical societies, foreign as well as French. The original accounts put forth respecting the Grande Salle were exaggerated; it appears that the total number of places is 4,400, divided as follows:—Covered boxes, 336 places; open boxes, 224; pit, 1,303; gallery, 1,554; seats called "tribunes," 555; and in case of an overflow, 428 strapontins. These are stools or small chairs placed in the gangways when required, and it is surprising that the Commission should sanction the use of such seats; in case of an alarm of fire or any confusion they would give rise to the greatest danger, and for this reason their use has been denounced over and over again.

It is not stated whether the concerts will be given in the day time or in the evening, but the former is believed to be the arrangement; but it is probable that there will be evening meetings as well; and this brings up the question of the electric light, which is to be introduced to the world on a large scale at the exhibition. Experiments, which were very successful, were made some time since in the Palais de l'Industrie, and the other day the subject was treated at the Sorbonne by M. Jamin, of the institute, when the light was shown, naked and elevated in the courtyard, one at each end, to counteract shadows, as it is used at the railway station of La Chapelle and in several machine shops, and in the lecture-room within ground glass globes. The professor having reviewed the whole subject with great clearness, introduced Mr. Jablochkoff, who lighted eight of his "electric candles" in one circuit; there was a large attendance of the members of the Academy of Sciences, including M. Dumas, the secretary, and much satisfaction was expressed. It was said, but not officially, that the Place de l'Opera and the Trocadéro are both to be lighted up to show the effect; lights are also to be placed at the summit of the two towers of the Trocadéro building, nearly three hundred feet high. It is understood that the fullest possible illustration of the subject of the application of the electric light will be given, and this would not be unless the admirable system of illumination by reflection were included, and the Grande Salle on the Trocadéro is the only portion of the exhibition buildings which would lend itself readily to the purpose.

An American paper says that the aid of the telephone is being secured in Jersey City in connection with the Courts. A telegraph wire is being laid from the Hudson County Court-house to the telegraph office in Montgomery-street, and a telephone will be attached to each end, whereby lawyers can communicate with each other rapidly between their offices and the Court-house.

It is announced that up to the end of last year 8,388 trade marks have been registered in this country. Fermented liquors are at the top of the list in point of members.

The opening of the Cape Colony International Exhibition is fixed for Monday, July 1st.

DURABILITY OF WOOD.

The durability of wood is a subject of such vast importance that every one, whether connected with its culture and growth, or use and application, should make himself thoroughly acquainted with it. Having devoted a considerable amount of study and attention to it, I shall enumerate some of the results, and allow the reader to draw from them his own inferences. A farmer in Strathspey, in the parish of Duthil, upon whose veracity I could fully depend, told me that over fifty years ago he erected two cattle sheds, the one at the base of a hill, and the other at the top, at about 600 feet altitude. Both sheds were constructed of the same kind and description of wood, namely, native Scotch pine. At twelve years the one at the base of the hill showed marked signs of decay, and had to be renewed at the end of fifteen years, while the other, at the top of the hill, at the latter period was found to be almost as sound as when erected, and at the end of thirty years the one at the top was as sound as that at the bottom, which had been renewed. In other words, the shed at the top of the hill had lasted twice as long as the one at the bottom, the wood of both being alike.

In the county of Roxburgh, and parish of Jedburgh, a three-rail Scotch paling was erected around a belt of advanced hard-wooded trees, the line of the belt extending from east to west. The rails consisted of plantation Scotch pine, from trees fifty years old, sawn into lengths of 18 feet, 4 inches by $1\frac{1}{8}$ inch, and the posts, which were sharpened and driven into the ground, were about 4 inches square, and of the same age and quality as the rails. At ten years old the paling on the south side of the belt was quite rotten and required renewal, while on the north side it required scarcely any repairs till nearly twenty years old, the posts excepted; these at the surface of the ground decayed about equally on both the north and south sides of the belt.

In the same county and in the parish of Oxnam, I saw two gate-posts taken out of the ground which had stood in the fence 38 years. They were put in when the plantation fence was erected in 1821, and taken out in 1859. When taken out the whole of the sap-wood had long previously decayed, and only the heart-wood and skeleton parts of the roots remained, but sufficiently strong to support a light rustic gate. The wood was Scotch pine, taken from a plantation 70 to 80 years old, and grown upon the top of a hill about 800 feet above the level of the sea, and upon poor heathy moorland with a gravelly subsoil.

A post and rail fence stood up to a few years ago upon the roadside at the village of Carrbridge, Strathspey, composed of native Scotch pine, both posts and rails. The former were all of heart-wood, the sap-wood being all shaved off before erecting the fence, and roughly squared with the axe to about six inches. The posts were pitted, and secured at the surface of the ground with stones. The soil in which they stood was an open gravel or shingle, and dry at all seasons. The man who erected the fence gave me the exact date, which to the time I last saw it made it 42 years old. Some of the posts were far gone with decay at the surface of the ground, but many others of them to appearance might stand 20 years longer. The posts were from old, but not large trees, and mostly grown upon peaty soil of a wettish nature, and at an altitude of about 1,000 feet above the sea level.

Another example of the durability of the Scotch pine came under my observation a few years ago, in the county of Banff and parish of Ruthven. It was that of two gate-posts at a farm steading. The posts were of native Scotch pine grown in the parish of Abernethy, Strathspey, and were, according to the practice of the time, floated down the river Spey to Garmouth. The exact date of erecting the posts is unknown, but the present tenant of the farm (Mr. Milne) testifies to their having stood over two nineteen years leases in his time

(thirty-eight years) and at least ten years before that time. On examining the posts carefully, I find them considerably decayed at the top, but, contrary to general results, quite strong and substantial at the surface of the ground; and it was only on account of their decayed tops that their removal was contemplated.

The posts were the product of comparatively small trees, such as would square to about 6 in., and, by counting the concentric rings, or annual layers, I found the trees to have been about 70 years old when cut. Nearly all the structure is duramen, or heart-wood, there being only about half an inch of sap-wood upon the surface. The posts had been put in nicely round, having only received a slight chip with the axe on the four sides and the bark removed. The posts stood on the north side of the dwelling-house, and shaded from the direct rays of the sun. The soil is a damp or wet clay, over the surface of which is sprinkled a few inches of sea gravel.

Having cited the preceding examples of Scotch pine, its durability and preservation, I shall refer to the larch in a future paper.—C. Y. Michie, in the *Gardeners' Chronicle.*

CLUNY MUSEUM.

Additional rooms have lately been opened in the museum of the Hôtel Cluny, and a new catalogue is being prepared, which will contain a vast number of important objects recently acquired. The existing catalogue does not give a quarter of the collection, which is full of interest, and, owing to the new arrangements, will be seen to better advantage than previously.

One of the principal additions recently made to the museum is a collection of Persian ware, which has occupied M. du Sommerard's attention for many years. Such a complete series of Persian faïence exists in no other public museum, though that at South Kensington is remarkable also.

Generally, the objects contained in the Museum of Cluny are original; but reproductions have been admitted. One of these, recently added, is a copy of one of the most famous examples in existence of mediæval goldsmiths' work, the *chef*, or reliquary, of Sainte Marthe, the gift of Louis XI. to the church at Terascon, dedicated to the patron saint of Provence, in 1478. It is a most ornate and exquisite work, by one of the most noted goldsmiths of the time, André Magot. The copy was made in 1628 by another eminent art workman, Couche, and like the original is studded with pearls and gems; it was found accidentally at Valence, by an officer in the French army.

Another acquisition is an equestrian statue, in wood, of Jeanne Darc; it is very old and curious, but nothing seems to be known of its origin.

Amongst the recent acquisitions are examples of the fine iron work of the fifteenth century; some very curious clocks and astronomical instruments, including copper astrolabes, a very curious medallion in rock crystal and enamel of the sixteenth century; Venetian and other dresses, and rare tissues of the sixteenth and seventeenth centuries; a collection of great importance, bequeathed to the museum by M. Janvier d'Attainville, including Italian vases of the 16th century, gilt bronzes of the same period, tapestry, Limoges and cloissonné enamels, and Gastelli faïence, one cup, or *coupe*, very remarkable, some fine carved doors, and other woodwork, mediæval and Renaissance, and a number of other objects of interest which will shortly be visible.

In the great room of the museum is a reredos, one of the finest known, purchased a short time since at the sale of the Duc d'Albe's collections; it is 26 ft. in height, above the altar, and has a number of panels, with religious subjects painted in the style of the 15th century, niches with pierced canopies, &c. This interesting example came from a church in Spain, and it bears the arms of the province of Aragon. In the same room is the chain which, in the Middle Ages, was used to close the Rue de l'Arbre sec, Paris. (*Arbre-sec*, the dry tree, stands for the gibbet.)

Still more interesting to many visitors will be five tombs of Grand Masters of the Order of the Hospitallers of Saint John of Jerusalem, obtained at Rhodes last year by the Commission of Historic Monuments; these are said to be the only monuments of Grand Masters now existing, and their condition is tolerably good. Four of the tombs are of illustrious French grand masters—Pierre de Cornillon, 1354-5; Dieudonné de Gozon, 1355; Robert de Julhiac, 1374-6; and Jacques de Milly, 1454-61; but the most important of the five tombs contained the remains of J. B. des Wisins, whose family was Italian. The tombs bear inscriptions, armorial bearings, and some statuettes and bas-reliefs.

TRANSYLVANIA AS A SOURCE OF FOOD SUPPLY.

A letter addressed to the *Journal of the Society of Arts*, by Mr. John Fretwell, jun., on "Transylvania as a Source of Food Supply," having attracted the attention of the Hungarian Government, was forwarded by the Minister of Commerce and Agriculture to the Chamber of Commerce at Klausenburg, in Transylvania, with a request to test the correctness of Mr. Fretwell's opinion that beef, of a quality suited for English consumption, could be profitably forwarded from Transylvania to the London markets.

From the report of the Chamber of Commerce confirming the opinion of Mr. Fretwell, the following statements are copied:—

About 14,000 head of stall-fed cattle, the flesh of which would suit the London market, are annually sent to Vienna, and slaughtered there. The average price per 100 kilogrammes of this meat is from 56 to 60 florins in Vienna, or, deducting four florins for expenses, from 52 to 56 florins in Klausenburg. Reckoning, at present exchange, 115 fl. = £10, and 100 kilos. = 220 lbs. = 56 fl. per 100 kilos., equivalent in English money to 49s. 6d. per cwt., the price of inferior middling beef in Smithfield on the 1st January, 1878, being 42d. to 54d. per 8 lbs., or 49s. to 63s. per cwt., and of prime large, 56d. per 8 lbs., or 78s. 8d. per cwt.

If slaughter-houses and cold stores were erected in Klausenburg, so that the killed meat could be forwarded hence in refrigerator cars to Western markets, the following additional advantages would be gained:—

1. Since 14,000 stall-fed cattle would yield about 5,600 tons, and 16,000 grass-fed about 3,200 tons, and a saving of price of, at least, 20 florins per ton by the purchase in Klausenburg would be effected. This would make in 8,800 tons an annual saving of 176,000 florins.

2. The loss of weight resulting from the transport of living cattle to Vienna is at least 30 per cent., or, say, 264,009 kilogrammes on 30,000 cattle. Thus, by killing the cattle here, we should save, at 46 florins per 100 kilos., 147,840 florins annually.

3. By the present plan we expend about 4 florins per head for commission, feeding, stabling, and drovers wages. On 14,000 head we should save 56,000 florins.

4. London consumes weekly 18,000 head of cattle, and if it takes only 1,000 head a week from Vienna, the total weekly supply of which is 3,500 head, it would raise the prices of the Vienna cattle market. This rise of price would be avoided by erecting slaughter-houses here.

5. Wages are much lower here than in Vienna.

6. The waste products of the slaughter-house would bring higher prices here then in Vienna, because at present the hides and tallow of beasts fed here, and slaughtered in Vienna, are sent back to Klausenburg for sale.

By the co-operation of London capitalists with the members of our butchers' guild and the great distillers of our country, who are, at the same time, cattle breeders, the whole cattle trade of Transylvania would concentrate itself at Klausenburg, and the quantity of stall and grass-fed oxen available for the London markets could be gradually increased.

Mr. Fretwell's comparison of the prices of mutton here and in London is correct. We could only export a limited quantity at present, but by crossing our breeds with the best English races, we could increase the quantity suited for the London markets.

CORRESPONDENCE.

INDIAN COMMERCIAL PRODUCTS.

In reading the able paper by Lieutenant-General McMurdo in last week's *Journal*, and the discussion thereon, I was much struck by some of the remarks made, especially those referring to the largely increased production of tea and coffee, these, however, being somewhat qualified by a doubt expressed by one of the speakers whether productive power was not outstripping consumption. Now, although judging from the profits declared by most of the associations concerned in these two industries, that epoch does not, as yet, appear to have been reached, it may be well to consider whether fresh channels for the investment of capital in productive industries cannot be developed, more especially those of an agricultural character, demanding little engineering or mechanical skill, and on which the extraordinary cheap native labour, with the productive climate and natural advantages of India, may be brought to bear.

As a striking illustration of such an industry I need only mention jute, hardly known in the country a few years ago, the importations now exceeding 300,000 tons annually, the demand too continually increasing, not only in England but in India itself, where of late, availing themselves of the cheap native labour, and saving of freight, manufactories have been established and are rapidly extending for its conversion into yarns and textile fabrics.

My object in the foregoing remarks is to attract attention to what I believe will, once fairly introduced, prove to be an equally important staple, and equally capable of a similar extended development; this being the utilisation of bamboo as a paper-making material.

That the successful introduction of such an industry would result in great advantages not only in providing fresh channels for native labour, and in promoting increased commercial and shipping relations between India and this country, but in materially assisting an important trade, that of the manufacture of paper, there can be little doubt.

Since the abolition of the excise duty on paper, in 1861, it is estimated that the consumption of paper in this country has increased 300 per cent., amounting now to upwards of 300,000 tons yearly, the demand due to the spread of education continually extending in a far greater ratio than the supply of raw material for its production. For our main staple, indeed, esparto grass, of which upwards of 200,000 tons yearly are imported, we are entirely dependent on foreign countries; whereas, by utilising bamhoo, a plant growing indigenously in India (or produced under an extremely simple system of cultivation under irrigation), we should secure an unfailing supply of a fibrous material far superior to esparto at a cheaper rate.

The paper I have made from bamboo proves the availability of the fibre, and I am prepared with ample data to show that under ordinary favourable circumstances the establishment of this industry would yield a fair commercial profit.

I have merely to add that I shall be happy to confer with any parties who may desire further information, or who may take any interest in the question.

THOMAS ROUTLEDGE.

Claxheugh, Sunderland,
27th March, 1878.

EMERY WHEELS FOR GRINDING AND SURFACING METALS.

In the discussion on the above, page 368, what I meant to convey was, that the objection to the use of emery wheels at Sheffield might not be wholly attributed to conservatism, but to the knife, scissor, and razor manufacture not being so suitable to their use; those fine articles being forged as nearly as possible to the pattern, are then filed into exact shape, and fitted whilst soft, then hardened and tempered, ground, glazed, &c. Shear steel articles may receive their last finish by the finest glaze wheel of emery, but the finest cast steel articles can only receive their polish with the crocus wheel; my observations on the file were the opposite of what I am reported to have said. WILLIAM BOTLY.

PLAGUE OF MICE.

Captain Stab, the corresponding member of the Society at Smyrna, reports that they are visited this year with the plague of field mice, or rats, which have come down from the mountains, and are taking up the seed corn and everything they can devour, in their accustomed way. It may be remembered that Homer refers to Apollo Smynthius, who saved the Greeks from this scourge. His statue is represented with a mouse at his foot. In Macedonia and Western Asia Minor the plague is well known. They complain bitterly of it in the Western States of America.

Captain Stab wishes to know whether any remedy can be recommended. Mr. Frank Buckland told me that owls should be procured; but the mice came on suddenly, and there is no time to get owls. H. C.

NOTES ON BOOKS.

Treatise on Modern Horology. B. Claudius Saunier. Translated by Julien Tripplin and Edward Rigg, M.A. Part I. London: J. Tripplin.

The French work of M. Saunier on watch-making is admitted to be the standard work on the suhject, and it is this fact, according to the preliminary notice of the publishers, that has induced them to issue the translation, of which the first part (dated February) has recently appeared. The issue is to he completed in 26 monthly parts. The original work comprises 832 pages, with 78 wood-cuts and 21 coloured douhle-page copperplate engravings. All these illustrations are to be reproduced in the English translation, and thus one principal feature of the French edition will be preserved. The work, as far as can be judged from the specimen, is intended to be of a thoroughly practical and technical character, and is evidently meant for the use of only those conversant with the practical details of watch-making. This, indeed, is assumed from the commencement, for the author at once addresses himself to skilled workmen. It appears, in fact, intended to give the practical worker some share of that theoretical knowledge which is admittedly so much wanting among all our artisans. The first part deals with "Escapements," and is for the most part taken up by a sketch giving

the elements of applied mechanics for the use of watchmakers. Future numbers are announced to complete this portion of the subject, and to treat fully of "Depthing, Springing, and Timing," to quote from the prospectus.

The Advantages of Goat-keeping, &c. By Stephen Holmes. Published by the Author, at Ewell, Surrey.

This is a little treatise giving instructions for the care of the goat, and setting forth the advantages which the author considers will result from the keeping of goats. He shows that little trouble is required, and is enthusiastic as to the value of the addition which might thus be made to the food supplies of many small families. The goat seems to habituate itself to various modes of treatment. It may be kept in a stable, a yard, or wherever there is sufficient ground for it to range. Its milk is palatable and wholesome, whilst its food is certainly very much less costly, in proportion to the return made, than that of any domesticated animal, except, perhaps, the pig.

GENERAL NOTES.

American Patents.—The annual report of the United States Commissioner of Patents states that the total amount received by the bureau during 1877 was 732,342 dols. Its expenses of all kinds for the same period were 610,075 dols. The accumulated surplus over the annual expenses paid into the treasury to the credit of the Patent-office fund, was, on the 31st December, 1,114,222 dols. There were 13,029 patents issued to American citizens in 1877, and 590 to foreigners. Appropriations of 30,000 dols. for the reproduction of photo-lithographs destroyed by the late fire, and of 20,000 dols. for the printing of patents granted prior to 1867, are asked. A change by which the Patent-office printing shall be done under the supervision of the Commissioner, and not at the Government printing office, the publication of a digest of patented inventions, a requirement that patentees shall pay a final fee of 15 dols., and the cost of printing, and photo-lithography, and the establishment of a patent court as a more permanent tribunal than either the Board or Commissioner, to act as a court of appeal, are suggested.

A New Silk Material.—The utilisation of new substances as raw material for manufactures is a distinguishing feature of the scientific investigations of the nineteenth century. One of the most recent suggestions is the result of the researches of Herr Tycho Tulberg, an eminent German naturalist, on the products of the mussel. It will be remembered that it was from one of the mussel species the famous purple dye was in past ages obtained, and this colour gained an imperishable renown from its being adopted by the Roman emperors, and the imperial purple became the symbol of sovereignty. In these latter days animal products have been displaced by aniline dyes, and there is no likelihood of their regaining their former celebrity. The researches of Tulberg have not, however, been in the direction of dyes, but in the adaptation of animal products other than the silk-worm for silk yarns. The mussel (*mytilus edulis*) fastens itself to the rocks by strong threads, called by naturalists *byssus*, and it is this substance which it is proposed to utilise for the manufacture of silk. The material is of a silky texture, and very tough, and the experiments that have been made prove that it is well adapted for spinning into yarn. Already the *pinna*, one of the mussel tribe, has been manufactured into thin fabrics, although it is not in general use, nor at present of much commercial value, and the same obstacles to the use of the *byssus* of the common mussel are apparent. Notwithstanding the abundant supply of this popular shell-fish, it is difficult to see how a sufficient quantity of *byssus* can be collected to enable manufacturers to purchase the raw material at rates low enough for a marketable remuneration on the manufactured article. But the records of industrial progress testify to greater difficulties than these having been successfully overcome, and should the commercial value of the new material be satisfactorily demonstrated, there is no doubt some agency will be developed whereby the requisite supply may be obtained. At present it is sufficient to notice the discovery that has been made, and to welcome another instance of the results of scientific labour being for the advantage of manufactures.—*Textile Manufacturer.*

Oil Palm of Africa.—The African Oil Palm (*Elais guineensis*) is so closely associated with the yield of what is commercially known as palm-oil that in consideration of the vast importance of this product we seldom think of any other use to which the palm is put in its native country; however, the rich reddish-brown fruits are highly valued as an article of food, being generally used in the preparation of a well-known dish called "palm chop." This, when properly prepared, is described as being very delicious. The fresh fruits only are used. The outer pulpy portion of the fruit which contains the oil is separated and placed in a pot over a fire; a thick, rich, oily mass is so obtained in which any kind of meat may be put, some water added, and the whole seasoned with capsicums and salt according to taste, and stewed gently until the meat is thoroughly tender. It is always eaten with some boiled preparation of maize flour or of mandioca root. Mr. Monteno in his "Angola and the River Congo," described the dish as being both in taste and appearance like a rich curry, a flavour that might not be at all expected from the strong smell and often rancid taste of the palm-oil as seen in this country. A good cook, it is said, will make a very good dish with fresh oil when new fruits are not to be obtained. Palm wine is also obtained from the Elais similar to that procured from the cocoa-nut, the *Caryota urens*, and other palms in India. When the juice is first collected it is somewhat milky, like the milk of a cocoa-nut, to which the flavour may be likened, except that it is sweeter and richer. When brought down fresh in the early morning it is said to be perfectly delicious, without the slightest trace of fermentation, and consequently not intoxicating. In the course of a few hours, however, rapid fermentation ensues, more especially if the fluid has been collected or is kept in vessels in which wine has been previously fermented. It is seldom to be had perfectly fresh or pure, the natives never losing an opportunity to adulterate it either with water or old wine, and the collectors, it is said, have even been known to take water in the calabashes up the tree, to mix with the juice before bringing it down, when they thought that no other opportunity would occur of adulterating it before selling it. —*Gardeners' Chronicle.*

NOTICES.

THE LIBRARY.

The following works have been presented to the Library:—

Hydrogeological Survey, Part I., by Joseph Lucas. (London: Edward Stanford, 1877.) Presented by the Author.

Transactions of the Institution of Naval Architects, Vol. 18, edited by A. S. Woolley. (London, 1877.) Presented by the Institution.

Treatise on Modern Horology in Theory and Practice. Translated from the French of Claudius Saunier, by Julien Tripplin and Edward Rigg, M.A. (London: J. Tripplin, 1878.)

Proceedings of the Literary and Philosophical Society of Liverpool, Vol. 31. (London: Longmans; Liverpool: D. Marples and Co., 1877.) Presented by the Society.

The following Pamphlets also have been presented:—

Rational Spelling; a Conservative scheme for national spelling reform. A letter addressed to the Right Hon. the Earl of Beaconsfield by Dr. George Harley, F.R.S. (London: C. F. Hodgson and Son, 1878.)

The Depreciation of Silver; a Paper read before the East India Association, on February 7, 1877, by Colonel A. B. Rathbone. (London: 1877.) Presented by the Author.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at eight o'clock.

April 3.—"Our Wealth in Relation to Imports and Exports, and the causes of Decline in the latter," by E. Seyd, Esq. W. Hawes, Esq., F.G.S., will preside.

April 10.—"A New Method for Producing Cheap Heating Gas for Domestic and Manufacturing Purposes." By S. W. Davies, Esq., A.R.S.M.

African Section.

Tuesday evenings, at Eight o'clock.

April 30.—"The Progress of Agriculture and Stock Farming in the Colony of Natal." By Peter C. Sutherland, Esq., M.D., Surveyor-General of the Colony. The chair will be taken by J. A. Froude, Esq.

Chemical Section.

Thursday evenings at eight o'clock.

April 25.—"The Purification of Water by Filtration." By Gustav Bischof, F.C.S.

May 9.—"Some Recent Improvements connected with Alkali Manufacture." By James Mactear, Esq.

Indian Section.

Friday evenings at eight o'clock.

March 29.—"The Depreciation of the Value of Silver, with Especial Reference to the Exchange between England and India, and Suggestions for a Remedy." By Col. J. T. Smith, R.E., F.R.S., formerly Master of the Mint, Madras and Calcutta. Andrew Cassels, Esq., will preside.

May 3.—"The Telegraph Routes between England and India." By Major Bateman-Champain, R.E.

May 17.—"Agriculture in India." By F. C. Danvers, Esq.

Cantor Lectures.

Monday Evenings, at Eight o'clock. Third Course, for the present Session, will be on "Some Researches on Putrefactive Changes, and their Results in relation to the Preservation of Animal Substances." By B. W. Richardson, Esq., M.D., F.R.S. The First Lecture will be delivered on Monday, April 8; the dates for the remaining Lectures will be as follows:—April 15; May 6, 13, 20, 27.

MEETINGS FOR THE ENSUING WEEK.

Mon.....Farmers' Club, Caledonian Hotel, Adelphi, W.C., 5½ p.m. Mr T Rose, "Farm Work in Harvest."
Royal Institution, Albemarle-street, W., 8 p.m. General Monthly Meeting.
Society of Engineers, 6, Westminster-chambers, 7½ p.m. Mr. W. Schönheyder, "Equalising the Wear in Horizontal Steam Cylinders."
Royal United Service Institution, Whitehall-yard, 8½ p.m.
British Architects, 9, Conduit-street, W., 8 p.m. Robert W. Edis, "The Cistercian Abbey of Boyle, in Ireland."
Medical, 11, Chandos-street, W., 8 30 p.m.
Victoria Institute, 10, Adelphi-terrace, W.C., 8 p.m. Prof. Birks, "Modern Geogenies exemplified in their bearing on the Antiquity of Man."
London Institution, Finsbury-circus, E.C., 5 p.m. Prof. R. Bentley, "The Seed, and Germination."

Tues.....Central Chamber of Agriculture (at the House of the Society of Arts), 11 a.m.
Conference of Anglers (at the House of the Society of Arts), 8 p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Garrod. "The Protoplasmic Theory of Life and its Bearing on Physiology." (Lecture XII.)
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. T. Gibson, "The Huelva Pier of the Rio Tinto Railway."
Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.
Photographic, 5a, Pall-mall East, S.W., 8 p.m.
Biblical Archæology, 33, Bloomsbury-street, W.C., 8½ p.m. 1 Mr. R. Cull, "Memoir of the late H. Fox Talbot, F.R S." 2. Mr. François Lenormant, "The Assyrian and Babylonian Names for Copper and Brass." 3. Mr. Eugène Revillout, "Translation of an Egyptian Contract of Marriage." 4. Miss Gertrude Austin, "An Inscription of Psametik II. in the Museum of Palermo."
Zoological, 11, Hanover-square, W, 8½ p.m. 1. The Marquis of Tweeddale, "Contributions to the Ornithology of the Philippines. No. VII. The Collection made by Mr. A. H. Everett in the Island of Panaon" 2. Mr. A. G. Butler, "Descriptions of new Lepidoptera of the group Bombycites in the Collection of the British Museum." 3. Mr E. Onstelet, "Description du nouvelle espece de Casoar (*Casuarius edwardsi*).
Royal Horticultural, South Kensington, S.W., 11 a.m.

Wed.... **SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Ernest Seyd, "Our Wealth in Relation to Imports and Exports, and the Causes of Decline in the Latter."
Royal College of Physicians, Pall-mall East, S.W., 5 p.m. (Croonian Lectures.) Dr. Pavy, "Points Connected with Diabetes." (Lecture III.)
Entomological, 11, Chandos-street, W., 7 p.m.
Microscopical, King's College, W.C., 8 p.m.
Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.
Archæological Association, 32, Sackville-street, W., 8 p.m. 1. Mr. Thomas Morgan, "Through Spain to Italica." 2. Mr. C. H. Compton, "Reservations in Old Leases granted by the Bishops of Hereford."
Obstetrical, 53, Berners-street, Oxford-street, W., 8 p.m.
Society for the Development of the Science of Education, United Westminster (Endowed) Schools, Alexandra-street, Victoria-street, S.W., 7.30. Mr. J. Moore, "Difficulties in Dealing with Untruthfulness in Children."
Geological, Burlington House, W., 8 p.m. 1. Mr. George Maw, "An Unconformable Break at the Base of the Cambrian Rocks, near Llanberis." 2. Mr. J. Arthur Phillips, "The so-called Greenstones of Central and Eastern Cornwall." 3. Mr N. H. Winchell, "The Recession of the Falls of St. Anthony." Communicated by Mr. J. Geikie. 4. Mr. C. T. Clough, "The Contemporaneous Appearance of the Teesdale Whin Sill."

Thur.....Royal, Burlington House, W., 8½ p.m.
Antiquaries, Burlington House, W., 8½ p.m.
Linnean, Burlington House, W., 8 p.m. 1. Prof. J. O. Westwood, "Some Minute Hymenopterous Insects." 2. Mr. M. C. Cooke, "The Fungi of Texas." 3. Rev. Thos. Powell, "Remarks on the peculiar Properties ascribed to a Fungus by the Samoans."
Chemical, Burlington House, W., 8 p m. Lecture on "The Application of the Microscope to some Special Branches of Chemistry."
London Institution, Finsbury-circus, E.C., 7 p.m. Prof. J. Rolleston, "The History of some of our Domesticated Animals."
Society for the Encouragement of the Fine Arts, 9, Conduit-street, W, 8 p m. Mr. J. Forbes Robertson, "The Historic Relation of Secular to Sacred Art."
South London Photographic (at the House of the Society of Arts), 8 p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Chemistry of the Organic World." (Lecture XI.)

Fri ......Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Mr. G. J. Romanes, "The Philosophy of the Beautiful."
Geologists' Association, University College, W.C., 8 p.m.
Philological, University College, W C, 8 p.m.
Archæological Institution, 16, New Burlington-street, W., 4 p.m.
Royal College of Physicians, Pall-mall East, S.W., 5 p m. (Lumleian Lectures). "Insanity in its Legal Relations." (Lecture I.)

Sat......Royal Institution, Albemarle-street, W., 3 p.m. Mr. Ernst Pauer, "The Clavecinistes and their Works: England and Italy, France and Germany." With musical Illustrations on the Harpsichord and Pianoforte. (Lecture I.)

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,324. Vol. XXVI.

FRIDAY, APRIL 5, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1878, early in May next. This medal was struck to reward "distinguished merit in promoting Arts, Manufactures, or Commerce," and has been awarded as follows:—

In 1864, to Sir Rowland Hill, K.C.B., "for his great service to Arts, Manufactures, and Commerce, in the creation of the penny postage, and for his other reforms in the postal system of this country, the benefits of which have, however, not been confined to this country, but have extended over the civilised world."

In 1865, to his Imperial Majesty, Napoleon III., "for distinguished merit in promoting, in many ways, by his personal exertions, the international progress of Arts, Manufactures, and Commerce, the proofs of which are afforded by his judicious patronage of Art, his enlightened commercial policy, and especially by the abolition of passports in favour of British subjects."

In 1866, to Professor Faraday, D.C.L., F.R.S., for "discoveries in electricity, magnetism, and chemistry, which, in their relation to the industries of the world, have so largely promoted Arts, Manufactures, and Commerce."

In 1867, to Mr. (now Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S., "in recognition of their joint labours in establishing the first electric telegraph."

In 1868, to Mr. (now Sir) Joseph Whitworth, F.R.S., LL.D., "for the invention and manufacture of instruments of measurement and uniform standards, by which the production of machinery has been brought to a state of perfection hitherto unapproached, to the great advancement of Arts, Manufactures, and Commerce."

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c., "for his numerous valuable researches and writings, which have contributed most importantly to the development of food economy and agriculture, to the advancement of chemical science, and to the benefits derived from that science by Arts, Manufactures, and Commerce."

In 1870, to M. Ferdinand de Lesseps, "for services rendered to Arts, Manufactures, and Commerce, by the realisation of the Suez Canal."

In 1871, to Mr. (now Sir) Henry Cole, C.B., "for his important services in promoting Arts, Manufactures, and Commerce, especially in aiding the establishment and development of International Exhibitions, the development of Science and Art, and the South Kensington Museum."

In 1872, to Mr. Henry Bessemer, "for the eminent services rendered by him to Arts, Manufactures, and Commerce, in developing the manufacture of steel."

In 1873, to M. Michel Eugène Chevreul, For. Memb. R.S., "for his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history, which for more than half a century have exercised a wide influence on the industrial arts of the world."

In 1874, to Mr. W. C. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the Arts; and for his improvement in the manufacture of iron; and generally for the services rendered by him in connection with economisation of fuel in its various applications to the Manufactures and the Arts."

In 1875, to M. Michel Chevalier, "The distinguished French statesman, who, by his writings and persistent exertions, extending over many years, has rendered essential service in promoting Arts, Manufactures, and Commerce."

In 1876, to Sir George B. Airy, K.C.B., F.R.S., the Astronomer Royal, "for eminent services rendered to Commerce by his researches in nautical astronomy, and in magnetism, and by his improvements in the application of the mariner's compass to the navigation of iron ships."

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., member of the Institute of France, "the distinguished chemist, whose researches have exercised a very material influence on the advancement of the Industrial Arts."

The Council invite members of the Society to forward to the Secretary, on or before the 20th of April, the names of such men of high distinction as they may think worthy of this honour.

NATIONAL TRAINING SCHOOL FOR MUSIC.

Various movements in favour of this school are going on. Birmingham has declared the establishment of a seventh free scholarship, which will be held by a student after Easter. An extensive association throughout Lancashire for promoting music as a means of culture among all classes is being organised, with the Bishop of Manchester as president. Special teachers of music for elementary schools and night classes are to be trained, and in Manchester competitions will be held to award scholarships at the National Training School.

INDIAN SECTION.

A meeting of this section was held on Friday evening, March 29th, Mr. Andrew Cassels in the chair. A paper was read by Col. J. T. Smith, R.E., F.R.S., formerly Master of the Mint, Madras and Calcutta, on "The Depreciation of the Value of Silver, with Especial Reference to the Exchange between England and India, and Suggestions for a Remedy." Owing to the length of the repor of the meeting, and the pressure of other matter, its publication is unavoidably postponed till nex week.

CHEMICAL SECTION.

Thursday, March 28; R. J. Mann, M.D., in the chair.

The Paper read was—

ELECTRIC LIGHTING.

By Dr. Paget Higgs.

I feel that it is great good luck that I am among the first to bring to the notice of this Society, so great a pioneer in the application of science to industrial arts and manufactures, some details on the subject of electric lighting. This subject is not only now of the highest importance to certain technical classes, it also gives promise of development to matters concerning our lives as private individuals. As a mode of public illumination it has attained definite success.

Time was when subjects still in the domain of science were very far from industrial realisation; to-day an invention or discovery is in the hands of the investigator in his laboratory; to-morrow it is universally applied, and the world wonders how it ever did without it in its absence. The railway and the telegraph are not very ancient inventions; there are still living many thousands who have travelled by stage-coach and thought ten miles an hour wonderful speed; and the telegraph is not yet a generation old. We all have heard of the telephone. We know that it can be used for five hundred miles or more on a practical telegraph line; two years ago, had we been told that we could hear our friends laughing a day's railway journey distant, we should have regarded our informant as indulging in tall talk. A few months ago many of us had never heard of the phonograph, now we know that we can effectually register speech.

With these precedents, how can we say that electricity, which is even now far removed from the *rôle* of a mere laboratory aid, may not, in perhaps some such short period, be a means of illumination generally adopted. At the present moment, as far as I know, there is no competition between our present means of illumination, namely, gas lighting and electric lighting. I use the term no competition, because these two illuminating methods have, at the present time, two distinct fields. Electricity is still at a disadvantage in its application to the lighting of small spaces, or where many small lights are required. Gas is not advantageous in the lighting of large spaces. It might also be said that it is under considerable disadvantages in the lighting of public thoroughfares; and that, when it is employed for the lighting of large engineering or open-air works, it is absolutelly ineffective. By its aid, also, it is impossible to distinguish colours, however brilliant or perfect its light may be. It is well known that blue and green—unless the latter be a so-called gas-light green—cannot be distinguished in gas-lighted rooms. Further, even in large enclosed spaces, the use of gas is attended with a deterioration of atmospheric purity prejudicial to health. With the electric light, on the contrary, not only does the light leave the oxygen of the air unconsumed and uncontaminated, but, by generating ozone, it might be said to act as a purifier. That this generation of ozone is not inconsiderable is known to every one who has stood within a few yards of the electric light. For this reason alone we should look forward with increased interest to the probability of electric lighting in its domestic application.

In the course of this paper I shall endeavour to show the relative economies of electric lighting and gas lighting, as applied to manufacturing industries. But electric lighting, supposing that its economy would not be less than that of gas, would still have many and important advantages over gas lighting in certain cases. For instance, the intensity of its light admits of large works of an engineering or constructive character being carried on practically, as well by night as by day. No method of gas lighting has yet attained this position. In silk mills, dye works, picture galleries, stores, &c., where to distinguish colours by night as by day enables the manufacturer or vendor to labour continuously, gas lighting must again give place absolutely to electric lighting; for by the electric light scenes are painted, rooms decorated, delicate colours assorted, and looms fed as well as by day.

The advantages of the electric light have also been found in shipbuilding, and with ships themselves upon the ocean; it is unrivalled for lighthouse applications, and it promises to afford a means to the submarine diver that daylight itself has not achieved.

In the fine arts, it will, undoubtedly, be used to illuminate our picture galleries, as it is now used to light portions of the Louvre at Paris. To photography it has given so much assistance that your sun-picture may by taken by this artificial sunlight at midnight. Of its use in war, in detecting the movements of attacking armies, the course of torpedo-boats, &c., it is unnecessary here to say anything.

The applications thus briefly noted are to be regarded as accomplished facts, In soliciting your attention to the description and details that follow, it is necessary to state definitely and decidedly that the application of the electric light to industrial purposes is no longer a commercial idea, but that in consequence of the recent rapid marked improvements in electro-magneto apparatus, electric lighting demands the attention of every manufacturer and constructor, not only as a system of lighting superior to any other in use for his purpose, but because by it results may be had that have hitherto been unattainable.

Electric lighting, as a system for lighthouse illumination and experimental purposes, has been known for some years, but from the large space occupied by the megneto-electric machines, their cost, and the high motor power required to drive them, its practical use has been limited.

Going back to first principles, we have that of magneto-electricity as discovered by Faraday. His experiment with a bar of iron surrounded by a coil or spiral of wire, and the production of electric currents in the coil by approaching to or drawing a magnet from the bar, and the correlative laws, are well known. Pixii, in 1833, constructed the first magneto-electric machine, upon which Saxton and Clarke improved. With these machines an electric current was obtained by causing permanent magnets and coils of wire to revolve with their poles in juxtaposition. Nollet, of Brussels, im-

proved and enlarged Clarke's machine, and modifications of this machine has been constructed by Holmes, of London, and the Compagnie l'Alliance, of Paris. In 1854, Dr. Werner Siemens, of Berlin, improved the revolving coil giving to all magneto machines with permanent magnets, what may be considered, at the present time, as the final step in this description of machine. But electric machines with permanent magnets are disadvantageous in use, because increased dimensions (beyond certain limits) do not give increased electrical results.

Magneto - electric machines (with electro-magnets) of the present powerful construction are due practically to Dr. Siemens and Sir Charles Wheatstone, who, within a short period, independently discovered the principle of accumulation by mutual action. Taking advantage of the fact that iron always has a certain amount of magnetisation said to be residual or remanent, these inventors cause a coil of wire to revolve between the poles of an electro-magnet which is in electrical circuit with the coil itself. Starting with the current induced in the coil by the residual magnetism, this current passes from the coil to the electro-magnets, making them more strongly magnetic, and giving rise to still more powerful currents in the coil.

Magneto-electric machines based upon this principle are now in use under two forms of construction. Of these forms, I have only one to show you, namely, the Siemens machine. The machine invented by M. Gramme, of Paris, and extensively used in France, I do not purpose to describe, as the results obtained by both machines are so similar, that a description of one will afford understanding of the other. However, in dealing with the question of economy, I shall borrow largely from the published results given by M. Gramme, as aiding to show the advantages of electric lighting from the point of view of two independent sources.

In the latest form of construction of the Siemens magneto-electric machine, the armature, as the revolving coil may be called, consists of several lengths of insulated copper wire coiled in several convolutions upon a cylinder, as shown in transverse section in Fig. 1, in longitudinal section in Fig. 2, and in perspective view by Fig. 3. The whole surface of the cylinder is covered with wire, laid on in sections, each convolution being parallel to its longitudinal axis. For about two-thirds of its surface, the wire cylinder is surrounded by curved iron bars, there being just sufficient space left between these curved iron bars and the wire cylinder to allow of its free rotation. The curved iron bars are prolongations of the cores of large flat electro-magnets; the coils of these electro-magnets and the wire on the cylinder (from brush to brush) form a continous electrical circuit. On revolving the cylinder (which is supported upon a longitudinal axis in suitable bearings, the axis carrying a pulley) an initially weak current is generated into its wires by their passage through the magnetic field formed by the residual magnetism of the iron cores of the electro-magnets, and the current being directed into the coils of the electro-magnets, increases the magnetism of the cores, which again induce a stronger current in the wire cylinder. This mutual action may continue until the iron has attained its limit of magnetisation. The maximum magnetic power acting upon each convolution is attained at every revolution of the armature, when the convolution passes through the centre of both magnetic fields, and gradually falls to zero as the convolution becomes perpendicular to that position. Each convolution has, therefore, a neutral position, and a convolution leaving that position on the one side of the axis and advancing towards the north pole of the electro-magnet, would be subject to a direct induced current, and that portion of the convolution on the opposite side of the axis would be traversed by a current of opposite direction, as regards a given point, but of the same direction as regards circuit.

Each of the sections of wire coiled upon the cylinder consists of two separate coils, leaving four ends; two of these ends are connected to each of the segments of a circular commutator divided into parts. But all the coils are connected to the several segments of commutator in such a manner that the whole of the double sections form a continuous circuit, but not one continuous helix.

Two brushes, placed tangentially to the segments of the commutator, collect the electric currents; these brushes are connected one to each electro-magnet, and the two free ends of the electro-magnet coils are connected to the conducting wires leading to the lamp.

The dimensions, weight, number of revolutions made by the armature, light equivalent in normal candles, and h.p. required for driving, are for three sizes of machines as follows:—

Dimensions in inches lgth.	wdth.	hght.	Weight in lbs.	Revolutions of cylinder.	Candles' light.	H.P.
25	21	8·8	298	1,100	1,000	$1\frac{1}{2}$ to 2
29	26	9·5	419	650	6,000	$3\frac{1}{4}$ to 4
44	28·3	12·6	1,279	480	14,800	9 to 10

The lamp which it is preferred to use with the Siemens machine is shown in Figs. 4 and 5 (p. 395). If the carbons be inserted in their holders, they will, on their points being separated, be brought together again by the gravitation of the top carbon and its holder. The descent of the top carbon actuates, by means of the straight rack it carries at its lower end, a large pinion, the spindle of which carries a small pinion gearing into a second neck attached to the lower carbon holder, the superior weight of the top carbon and holder in conjunction with the multiplying ratio of the two pinions producing a continual tendency of the carbons to approach each other. The large and small pinions are connected to each other, and to the spindle that carries them, by an arrangement of friction discs, and the object of this construction is to allow of the two racks being moved equally and simultaneously up or down for the purpose of focussing the light when required. This movement is effected by means of the bevelled gearing, shown in the upper part of the casing, and actuated by a milled head which can be pressed into position when required. On the spindle carrying the large and small pinions and the friction discs, is placed a toothed wheel connected with the spindle by a pawl and ratchet. This wheel is the first of a train of wheels and pinions driving a regulating fly in the usual way. The pawl and ratchet are provided to allow of the rapid distancing of the carbon holders when it becomes necessary to introduce fresh carbons. The

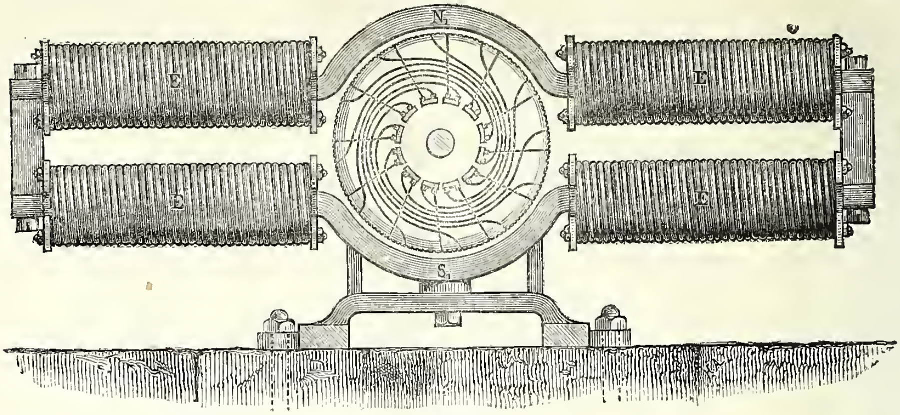


Fig. 1.

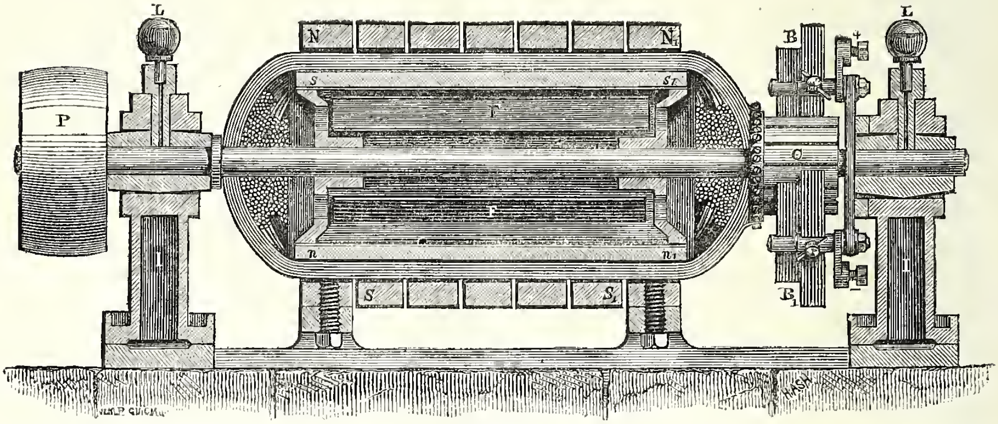


Fig. 2.

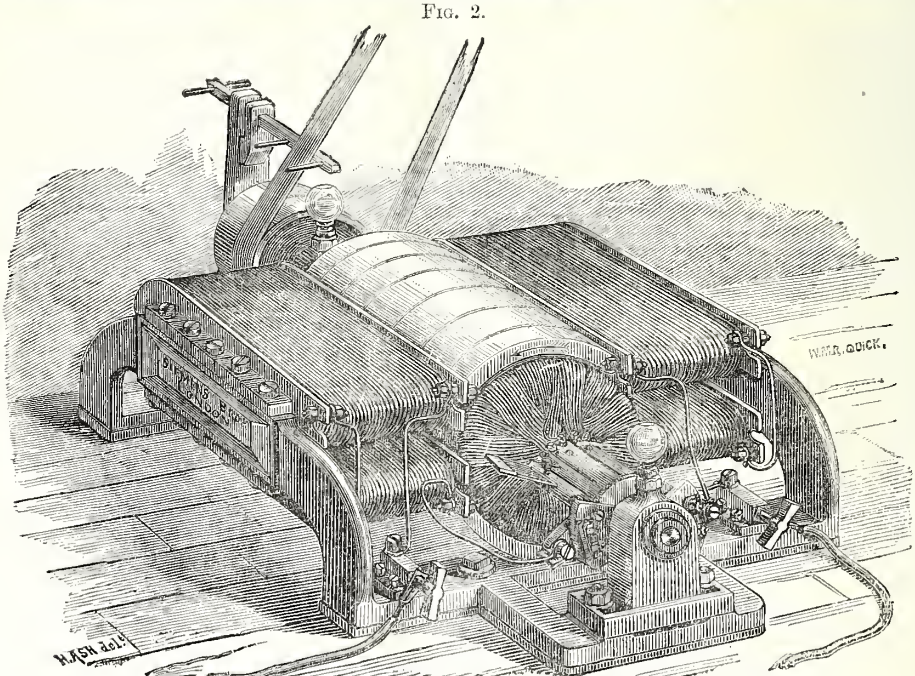


Fig. 3.

spindle of the fly also carries a small finely-toothed ratchet wheel. This ratchet wheel is actuated by a spring pawl, carried at the end of a lever, which lever is the continuation of the armature of the electro-magnet, in such a manner that when the armature is attracted by the electro-magnet, the

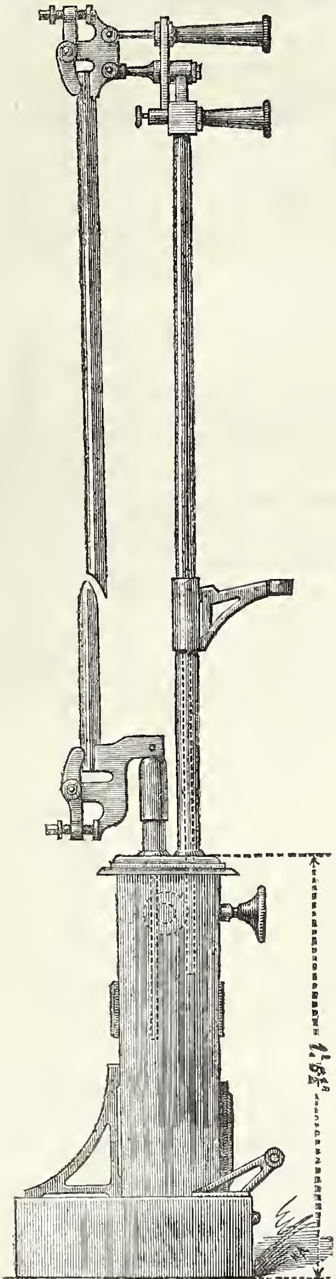


Fig. 4.

spring pawl engages in the teeth of the ratchet wheel and causes the wheels in gearing therewith to act upon the racks of the carbon holders to draw them apart.

The action of the lamp is as follows:—The current passes from the conductor to the top carbon holder, thence through the carbons to the bottom carbon holder, then to the coils of the electro-magnet situated in the base of the lamp. From the coils of the electro-magnet the circuit is completed to

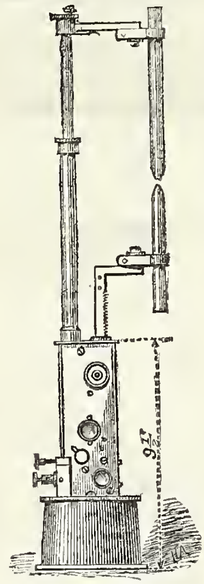


Fig. 5.

the other conductor. Upon the current passing through the circuit, the armature of the electro-magnet is attracted, and the abutment from the armature lever caused to short-circuit the coils of the electro-magnet, releasing the armature. The armature being released, the short circuit is removed from the coils of the electro-magnet, and the cycle of movement repeated; in this manner an oscillatory motion is given to the armature lever, which, by the spring pawl, actuates the ratchet wheel, the train of clockwork, and the racks of the carbon holders, forcing the carbons apart until the distance between their points sufficiently weakens the current, so that it no longer attracts the armature of the electro-magnet. Thus, by the combined action of gravitation of the top carbon in drawing the carbons together, and of the current to separate the carbons when they approach too closely, a working distance is maintained between the points with perfect automatism.

Magneto-electric machines have chiefly been employed for the production of the electric light, but they are also applicable for the transmission of power and for electro-metallurgical processes. In this paper we shall confine our attention to their use for the production of the electric light.

With regard to the improvements in recently constructed dynamo-electric machines, we learn from Professor Tyndall's report to the Elder Brethren of the Trinity-house, that magneto-electric machines of old construction cost ten times more, occupied twenty-five times the space, and weighed fourteen times as much as the recent machines, while they produced only one-fifth of the light, with practically the same driving power; that is to say, taking light effect in each case into

consideration, the new machines cost one-fiftieth, and are, as regards space occupied, a hundred and twenty-five times more advantageous than the earlier forms.

Against the use of magneto-electric machines for practical purposes, there has been quoted the disadvantage of stoppage due to wear and renewals, but in the present form of machines the chances of stoppage are no more than those that arise generally with machines of any ordinary construction. The Trinity-house report, previously referred to, states that the Siemens machine then tried "worked well from the 7th March to the 7th April without any necessity for a stoppage. On the 11th March the commutator plates and brushes were again adjusted; and on the 6th April, the commutator plates and brushes were renewed."

The limit to the duration of the light is at present set by the size of the carbons and the rate of their consumption, which depends much upon the power and quantity of the current, and consequently upon the size of the machine employed. In the lamps shown in the accompanying drawings, the lower carbon is eight inches, the upper carbon sixteen inches in length, and the holders are arranged to receive a round or square carbon of nine to twenty-one millimètres diameter or side. Eight to ten hours is the longest time of duration of the carbons. Attempts have been made to construct lamps with the carbons in the form of circular discs set edge to edge, and caused to revolve by clockwork in order to lengthen the duration of burning, and a lamp so constructed by M. Regnier has been said to have given good results, but the difficulty of obtaining homogeneous carbons may be considered to be insuperable to the practical introduction of this lamp.

I now come to the more interesting portion of my paper, that relating to the efficiency of electric lighting, and its comparison with methods of gas lighting. We may assume, I believe, without fear of contradiction, that gas cannot be manufactured under a cost, including working profits, of two shillings for one thousand cubic feet as an average price. A gas-burner of twenty candles light will certainly consume six cubic feet of gas per hour. Eight thousand candles light would necessitate four hundred burners, consuming two thousand four hundred cubic feet of gas per hour, costing four shillings and nine pence. The cost of fixing gas pipes, burners, cocks, &c., at ten shillings per burner, pipes included, would be £200. Assuming three hundred working nights, with an average time for lighting of five hours per night, or fifteen hundred hours, and reckoning cost of renewals, repairs, and shifting with work in progress, to be included in an interest of twelve per cent. per annum, we have—

	£	s.
Interest on £200	£ 24	0
Cost of gas for 1,500 hours	356	5
	£380	5

If only five hundred hours were worked during the year the cost would be—

	£	s.
Interest on £200	£ 24	0
Cost of gas	118	15
	£142	15

The cost of a magneto-electric giving this light intensity, with lamp and steam motor and connecting wires, would not exceed £250. The cost per hour for carbons, coals, attendance, oil, renewals, &c., may be taken at two shillings per hour under the most unfavourable conditions. This gives—

Interest on £250	£30
1,500 hours at two shillings	150
	£180

which is a ratio in favour of the economy of electric lighting of 2·1 to 1.

If five hundred hours' lighting be taken, the cost for the electric light would be £80, or in the ratio of nearly 1·8 to 1 in its favour. But this is not strictly a just method of estimating the value of the electric light, because the one lamp will brilliantly light a space which would be so badly illuminated by the distributed gas-burners that work could not be carried on except under great inconveniences.

An actual comparison of these methods of lighting may be made by referring to some data given by Messrs. Siemens Brothers from the system as employed by them in one of the departments of their telegraph works, which, previous to the introduction of the electric light, was imperfectly lighted with one hundred and twenty gas-burners. The imperfection of the light, and the progress of the work necessitated frequent alterations in the gas fittings. Each of the burners consumed six cubic feet of gas per hour at a cost of three shillings and nine pence per thousand. The cost of fixing gas pipes, including cost of pipes, burners, cocks, &c., for the whole number was £60; interest may be taken at 15 per cent., to include wear, tear, renewals, and removals, per annum. During extensive orders, day and night work are continuous, and one thousand hours' consumption per annum is below the actual expense.

	£	s.	d.
Interest	£9	0	0
Cost of gas consumed	135	0	0
	£144	0	0

The 120 burners will give only 2,400 candles' light; actually, but a per-centage of this is attained, and with steam or fog the gas jets are obscured. It is necessary to employ three lights for the three spaces to be lighted. Three machines, with lamps, conducting wires, and mounting, &c., cost £250.

	£	s.	d.
Interest at 15 per cent. on £250	£37	10	0
Carbons, coals, attendance, renewals, &c., for 1,000 hours	35	4	0
	£72	14	0

This is an economy of 2 to 1 in favour of electric lighting; but, if the ratio of light intensities were adopted, the advantage would be as 6 to 1 in favour of electric lighting.

The economy varies with the motor power; the light is cheapest when water power is to be had, and most expensive when a gas-engine is employed. At M. Dieu's workshop at Davours, with the Gramme machine, the cost per hour is 1s. 11d., against 2s. for gas. M. Ducommun states that the electric light costs two and a quarter times less than gas light, when wear, tear, and interest are taken into consideration.

It must not be forgotten that, in calculating these relative costs, the gas is taken as supplied to

other consumers than the works in question. If it were necessary to construct a special gasworks, requiring special technical knowledge and attention, where the waste products of the gas manufacture could not be utilised, the cost of the gas would rise to 10 to 12 times that of electric lighting, and in many cases would be absolutely inapplicable under conditions where the electric light might be easily instituted.

Generally, one small machine will illuminate five hundred square yards of fitters' shops and machine shops, and two hundred and fifty square yards of weaving and spinning mills, &c., while in the open air, on yards, and landing places, two thousand square yards may be easily and brilliantly illuminated with a single lamp.

In the celebrated chocolate factories of M. Ménier, fourteen machines are employed, and these are so arranged that the electric light can be supplied to the drawing and dining-rooms, conservatories, and gardens of the residence.

At Paris, the Chapelle-Paris goods depot has been provided with the electric light, with an economy in the staff of twenty-five per cent., for the reason that work can be carried on so much more expeditiously.

The electric light is in use in Paris, also in the magazine du Louvre, and the Avenue de l'Opera, the *Figaro* offices, the works of the new Grande Hotel, the Exposition buildings, and nearly every important public building in course of construction.

In the erection of the Tay-bridge by Messrs. Hopkins, Gilkes, and Co., two machines were employed, distant three hundred yards from the lamps, which were three hundred yards apart. The cost of working, including motor power and attendance, was about one shilling and fivepence per hour for each lamp. When both lights were thrown in one direction, a newspaper could be read at a distance of two miles.

Messrs. Head, Wrighton, and Co., of Stockton-on-Tees, have employed the electric light for night-work for about three months, during which time the interest on the outlay, superintendence, and cost of carbons was fully covered by the charge of one shilling per hour for a thousand candles' light.

These typical cases will serve to show that electric lighting supplies a long existing want in industry.

The methods of utilising the current for light purposes are still somewhat crude, and there is much yet to be done before the electric light can be employed with comfort in illuminating rooms and halls of ordinary dimensions. A source of inconvenience is the want of chemical purity in the carbon rods, but this inconvenience is not apparent in the lighting of large spaces, and, doubtless, when an efficient means of tapping or subdividing the electric current has been devised, the electric light will take the position of gas lighting in every household. And, although the attempts to subdivide the current, so as to obtain many smaller lights, have only promised, but have not attained success, I believe, I may conclude, as I have mentioned in the introductory remarks, that we cannot say how soon this may be brought about. Indeed, I have in the laboratories of my friends, both in England and France, seen arrangements in action that go very far to fulfil what is required, and I should not be surprised at any moment to learn that the difficulties have been overcome, and that the future means of illumination for all purposes would be electricity.

In utilising the electric light, the lamp is sometimes, as in lighting large spaces, unprovided with glass or shade; in other cases opal and milk glass globes are used to soften the light; but both these methods cause fatigue to the eye, when the operator or workman has the habit of looking directly at the light. To obviate fatigue from the direct rays, it has been proposed to place the electric focus in a reflector, and to project the rays upon a whitened ceiling, or upon another reflector, so as to diffuse a soft and pleasant light throughout the room. This method would also be applicable for street lighting, in thoroughfares or public places where the direct rays might be considered inadmissable.

In this paper I have purposely omitted to make mention of the Jablochkoff lamp, or so-called "electric candle." The attention of the members of this Society has, I believe, been called to this invention. Although in use in Paris, I am not aware that it is employed in England. These candles have serious drawbacks. They can be used only with a machine giving alternate currents. Such machines, for equal light effects, require a larger expenditure of motor power than machines that give a permanent current; the consumption of carbon is greater than in an electric lamp; and these disadvantages will, I am afraid, interfere with the extended introduction of this system of electric lighting. To M. Jablochkoff is, however, due the merit of opening up a new era in this method of illumination, because he showed how very nearly practical results were at hand.

I may conclude this paper with a resumé of the advantages of electric lighting. In the first place, electric lighting can be economically employed, both with regard to its intensity and colour effect, where gas-lighting or other modes of lighting are valueless. In lighting large workshops, stores, &c., electricity enters into competition with gas, both in economy and safety from fire.

I have to call the attention of the Society to the machine and apparatus put before them by Messrs. Siemens Brothers, and to thank you, Mr. Chairman, ladies, and gentlemen, for your attention to a paper that has unavoidably been fatiguing from the amount of detail it has involved.

DISCUSSION.

The Chairman said he remembered very well, certainly within 20 years, when it was a dogma of science that no mode of electric lighting ever could be economical, the reason given being that whereas in gas you were digging from the earth raw material, and turning that to effect by very slight mechanical appliances, you had in any form of electrical action to use a manufactured material. This dogma was almost universally held by scientific men. The reason why these developments, which science had given, enabled the problem to be accomplished, was simply due to this fact, that in all of them there was merely a conversion of motion into light. In either one of the machines shown they might use permanent magnets in the first instance. A permanent magnet of course could not go on producing force without being in some way wasted, but they knew that the

permanent magnet did go on without any material waste, day after day and week after week, producing the effects desired. This was simply because it was the motion communicated to the magnet, which was the source of power. The real loss they had to meet was the motive power, whether that were the power of water, steam, or any other force. There, at any rate, was the fact that what it was said it was impossible to do had been done, simply by the application of two principles. In the first place, the admirable idea of using residual magnetism to set up the first slight action which generated by multiplication, the electric current was quite analagous to the principle of Holtz's electric machine, where you had first to get a small amount of electricity which was applied to produce induction in the revolving disc of glass. Again, the great objection to electric lighting, apart from its use in those obvious cases where you wanted a very powerful light, to throw into tunnels or mines, or anything of that sort, was the glare and the disagreeable effect on the eye. One of these beautiful machines of Dr. Siemens's had been lately exhibited at the Royal Institution, showing a light equal to a thousand candles. But although it was a wonderful light, it was most disagreeable, and he would not have been compelled to sit at work where that was used under any consideration. Now, however, by the simple application of a parabolic reflector, and the system of reflection from the ceiling, the whole of that difficulty was removed. This was very interesting, and it was the same principle in fact as that which microscopists had applied for a long time under the name of "white cloud illumination."

Mr. B. F. Cobb asked for some further information with reference to the figures. In comparing the electric lighting with gas, he understood that the latter came to £144, and against that there were two items of £37 10s., and £35 4s., making a total of £72 14s., or an economy of two to one in favour of the electric mode of lighting. But, in an earlier part of the paper, Dr. Higgs stated that the smallest horse-power required to drive one of these machines was one and a-half or two, and it seemed to him, therefore, that the cost of this motive power required to be added to the figures.

Mr. Ladd had felt considerable interest in the question of electric lighting, having had considerable practice in it, especially in connection with batteries, which of course were not suitable where these machines could be used, because batteries wore out, and were not constant. At the same time, he believed he was the first who ever gave a continuous light upon the new principle, with dynamo machines, as they were called. By continuous, he meant a light comparatively continuous. His countrymen seemed to have forgotten this fact, though on the Continent they gave him credit for it. The facts were simply these. When Siemens and Wheatstone, who had been working at the same time upon dynamo machines, first introduced them to the Royal Society, small hand machines, both being presented on the same night, he had been at work in the same direction, but was not aware until then that they could be worked with the mere residual magnetism of iron, and had been working with permanent magnets. When he saw those machines, however, it immediately opened his eyes, and he saw his way to getting a good current. Neither Siemens nor Wheatstone could at that time put their machines to any practical work. They were worked by hand, and the thing soon got into a dead-lock; they could not obtain the power out of the machine. Siemens discharged the whole machine, and got a flash light, not a continuous one, because directly he broke contact the whole machine was discharged, and you had to work it up again. That did not take long, but still it was a flash light, and he believed that was Dr. Siemens' object at that time. Sir Charles Wheatstone, in order to divert a part of his current, put a piece of platinum wire across, which was kept at a red heat, diverting a part of the current through it which was made a short circuit, but still the whole thing came to a dead lock very speedily. In the following month he presented a small machine to the Royal Society, worked by a treadle, and used two armatures, one to charge the magnets and the other to take away the magnetism, and this gave nearly a constant current. That was a very small machine, but it kept a platinum wire very hot any length of time. It did not get into a dead-lock, because the magnetism was carried away by the second armature. In the same year he exhibited a machine of that construction at the Paris Exhibition, which he believed was the first which ever gave a continuous electric light. It excited a good deal of interest, and he had two men to attend to it every day, but, of course, when the electric light had to come out of men's arms it soon got feeble, and directly the light was produced it was found they had to stop and rest. However, the machine excited so much interest, both amongst French and German visitors, that he had a small steam-engine connected with it, and it was worked for hours together giving the electric light. He was quite aware tbat, in these machines now shown, second armatures were not used, but in the Gramme machine they were, and all he claimed was that his machine was a link in the chain, leading to the present. It had been superseded, because it took a great number of revolutions at a very high speed to get anything like a constant light. These machines, having so many breaks in the circle, did not require such a speed to work them. He believed the electric light would never succeed if a direct light alone were relied on, as it was too painful to the eyes; but it was too weak if shaded, and you would require several to be at all effectual. The arrangement of the reflector, throwing the light up, was certainly very good, but you wanted another one at the top, or else it would give very little light in a room like the one they were in, where the ceiling did not reflect it. With another reflector at the top, which would disperse the light, it would, no doubt, be a very effective plan of lighting. The electric light was now used most successfully in photography, but the direct, or reflected, light was never used on a sitter. Mr. Van der Weyde, of Regent-street, used it very successfully with Siemens's machines and a gas engine, and produced some of the best photographs had ever seen, the half-tones coming out most beautifully; but it was all refracted light. It was reflected first from a parabolic reflector placed behind the light, with a piece of metal in front, so that no direct light should come to the sitter; and in front of this reflector there was a prismatic arrangement by Messrs. Chance, and every alternate side of the prisms was either whitened or blackened, so that no light should come direct. If it did so, it would show a coloured light and surround the sitter with a halo which would not be advisable. The rays of light were made to fall parallel. He had often supplied electric lighting apparatus to photographers, but he always told them never to get the whole of the light possible from it. You did not want such a powerful light as the carbons would give. What was wanted for photography was a long arc, a number of cells if you used a battery, or a machine with considerable intensity, to give a long arc, and then you got a greater actinic effect. Mr. Van der Weyde told him he never used an arc of less than half an inch.

The Chairman said he presumed that was due to actinism being developed in a certain portion of the arc.

Mr. Ladd said the carbon points themselves gave light, but the arc was the sort of light required for photography. He did not agree with covering the carbons with copper, which he considered objectionable, and knew from much experience that the electric light given by metal was most painful to the eyes. When he had been trying experiments in spectrum analysis he found the light from metal was most painful; why he did not know. He could look tolerably well at

the carbon points, but when he began to burn metals between the points he could not endure it, although the light was not so strong.

Mr. Woodall, though he felt sure that Dr Higgs had desired to state only what had been proved by experiment, was obliged, nevertheless, to take exception to some of his figures. Mr. Cobb had already called attention to one omission. It was certain that any experiments conducted at Messrs. Siemens's works would have much care bestowed upon them so as to ensure success; and no doubt every reliance might be placed on the results stated; but it must be remembered that the comparison was made between gas purchased from a company supplying it for a commercial profit, and the electric light on the premises of the manufacturer of the machine, nothing being charged except the bare generation of the light. Making the required corrections from this point of view, the cost of the gas would be £75, instead of £144, or very little above that of the electric light. The cost of making gas would certainly not exceed the figure given of 2s. per 1,000, and at that rate, taking 120 burners at 6 ft. per burner, the cost would come to £72. Then Dr. Higgs put what he called the interest on the cost of the burners at 15 per cent., but in the case of the electric light 15 per cent. was made to cover both interest and wear and tear. Now if that were sufficient in the case of a machine going at the rate of 1,000 revolutions per minute, it was absurd to put the same rate on gas-fittings nailed to the wall, and never touched perhaps for 20 years. He should therefore take the interest on the cost of the fittings at 5 per cent., which would bring the amount up to £75 as the total cost for a thousand hours. But a thousand hours was an exceptional time for gas to be burning in any workshop; 500 hours, indeed, would be a high average, and taking it at that, the cost would come out £39, or very considerably less than the cost of the electric light. As a matter of course, the longer the electric light went on the better would the comparison come out. There was one important omission from the statement, because the £250 would just cover the cost of the machines and lamps, and, if you added the necessary motive power, the shafting, belting, &c., a considerable addition would have to be made to the first cost, and consequently to the items of interest and wear and tear. He quite admitted that in large workshops, where power was available without trouble or inconvenience, it might possibly be an advantage to have this exceedingly brilliant light completely illuminating the whole workshop, so that the foreman could efficiently superintend what was going on at any hour, but he maintained that, as a rule, this advantage would be gained at some cost. He had some figures, furnished from a workshp at Rouen, which showed that the cost was somewhat above that of gas. He was glad to hear Dr. Higgs say that there were still two fields open for these two modes of lighting. There could be no question that for lighthouse purposes, and in any position where one light of great power and intensity was required, the electric light was superb; but, under present circumstances, and taking this paper as a statement of the present position of electric lighting, they were still only able to hope for such improvements as would render it available for domestic purposes, or where subdivision was required. Dr. Higgs spoke of the Jablochkoff candles as being impracticable, but he believed it was only by improvements in that direction that electric lighting could ever come into competition with gas in its main field. To get the full economical advantage of the electric light, it must be used in centres of great intensity; if it were taken to several points there would be a loss of light in the division. Dr. Siemens had stated, for instance, that the combined currents from two machines would give considerably more illuminating power than the aggregate of the two used separately; and the converse applied, he believed, to the attempts which had been made to subdivide the current from one machine, there was a loss of power and economy. It was evident also, that, in order to get sufficient light wherever wanted, you must have an excess of light in one particular position, which must be wastefully expended. One point of considerable importance in noting the possible competition of the electric light with gas, was this, that if it were to be brought into practical work, such an amount of apparatus would have to be provided as would be equal to the generation of the whole amount of light required in the time of greatest consumption. A gas company, on the other hand, went on manufacturing during the whole 24 hours, and accumulating what was required for the eight hours of greatest consumption. It would, of course, add materially to the establishment charges and to the cost of plant if all the gas had to be generated during the time it was required for use. Electric science had been very happy in the men who had given attention to it, and the enormous progress which had been made in the manufacture of these electrical machines was very remarkable. Working it out, he found that the cost, not very long ago, of a machine for producing a light equal to 1,000 candles, was about £350, whereas now the price was only about £35.

Mr. Rochusson inquired what was the chemical composition of the carbon points.

Mr. Mercer did not quite gather from Mr. Woodall whether he had included the cost of motive power required to drive the machine. At the works of Messrs. Siemens that would not be very important, but it would be in places where special motive power had to be provided.

Mr. Woodall said he had referred to that point. There was, he thought, considerable liability on the part of many people, reading figures such as these, to fall into the error that, where there were engines on the premises, these machines could be driven by what was called spare power almost free of cost. As a matter of fact, if power were used whether in addition to that already employed or created for the purpose, it must be paid for in fuel.

Mr. Smartt said the use of gas had been spoken of as being 2s. per 1,000, but where he lived it cost 6s., which would materially alter the calculation in favour of electricity. A short time ago the electric light was introduced into some large premises with which he was connected, and he was informed that it answered very satisfactorily; but he was also told that the success resulted from using the power of one engine and one magnet for producing several lights by means of the new candle lamps. He should like to know the amount of loss arising from using one machine for a number of lights, and how many could be supplied from one machine. He believed it was owing to the imperfect state of the law in Prussia with regard to patents, that Dr. Siemens was induced to come to England, and we had thus obtained the benefit of his inventions, and he trusted this fact would have weight with the English Government in improving our Patent-laws.

Dr. Higgs, in reply to the observations which had been made, said in regard to the cost of the motive power at Messrs. Siemens's works, as far as he could understand, it cost nothing, because there was always so much excess power that it was not practically noticeable whether the machine was on the shafting or not. Coals had, however, been charged. The machines were charged at the ordinary selling price. As they gave light to a lamp which could be easily moved, there was no expense incurred in following the progress of the work in the shops as might be required; gas-fittings had to be taken down and put up, and he had included the cost of this in the 15 per cent., and he did not think this was too much to charge for a large establishment where two gas-fitters were almost constantly employed. Mr. Woodall had referred to the machines as revolving

at the rate of 2,000 revolutions a minute, but they actually ran at about 900, the maximum light being given with 1,100 revolutions. The only wearing parts were the commutators. The brushes required renewal about once in two or three months, and as they were simply composed of copper wire set side by side, the cost could not be very great. There were machines which had been in constant use for four years, which showed no signs of wear. He had taken the cost as two to one in favour of the electric light, but it must be remembered that with gas lighting the work was got through very slowly, with great difficulty, and constant complaints of bad gas. In the present case the work was got through much more expeditiously, and if the facility with which the work had been carried on were taken into account, it would add materially to the advantage of electric light; but as this was not a point which could be easily grasped, he had not included it. But there was one substantial point to be noted, viz., that, even in shaded lamps, electricity gave a light six to one higher in intensity than gas. There was the further and immense advantage of distinguishing colours, which could never be obtained from gas. In silk mills this was of great importance. You could distinguish a bluish green from a greenish blue at any time. With regard to the effect on the eyes, where men had to inspect narrow ribbons, or look over narrow slips, and carefully pick out any containing foreign substances, they were not required to look at the light, but at the strips, and if they had an intense light on their work it did not fatigue the eyes so much as a bad light. A bad light was more fatiguing than too good a one. When the electric light was first introduced, the workmen always wasted two or three hours in looking at the light and getting dazzled, but they soon got over the novelty and thought no more about it. The whole subject was very well treated in Fontaine's book on electric lighting, an English edition of which would soon be published. Throughout that book the same interest was placed on the cost of the electric machines as on the gas fittings, and in correspondence with different French authorities on this matter they said they had carefully considered the wear and tear of the machines, and did not feel justified in putting it any higher. His own experience, both in England and France, led him to concur in that view because, though the machine might be driven at a very high velocity, its mechanical construction and centering were so perfect as to incur only the minimum amount of wear and tear. Bearings would run for a long time at a high velocity, so long as they were truly centered and well lubricated. With regard to the division of the result, the result of the best experiments he had seen showed that a single light gave about 3 per cent. more light than that developed from 16 separate lamps. He did not say that lightning by 16 separate lamps was a practical success, it necessitated a certain amount of attention, and there were difficulties in the way, but he did not say that they could not be got over. Looking to the great stride made in these machines, they might hope that the solution of the problem of the subdivision of the light was not far distant. With regard to the subdivision of labour and the storing up of lighting power of gas, he would remark that this economy was included in the present cost of gas, and what it would be if supplied without that economy they could not say. At the present time they did not store up force for electricity, but there was no reason why it should not be done; why engines working a certain number of hours should not store up force just the same as was done in hydraulic machines. The electric machines seemed to have the advantage that they could be put up at any time, and in any place, wherever there was motive power to drive them. He was much obliged to Mr. Ladd for drawing his attention to a fact which he did not know before. He was personally acquainted with the Wheatstone machine, and wanted to know where the link was to be found between that and those now used. He could see now where it was. He was much obliged to Mr. Ladd for the information, and it would not be his fault in future if Mr. Ladd's name were not known in connection with this subject. There should have been an upper reflector sent with the lamp, to make it complete. It was generally found that a longer arc gave a greater actinic effect, but less luminous effect. With regard to the coppering of the carbons, the burning of the metal was not perceptible, because the coating was extremely thin. Sometimes he had tried it with a spectroscope, and although, of course, the green copper line was visible, it was not more perceptible than if you rubbed a copper brad along one of the carbon points. He did not think any painful effect would arise from coppering the carbons, but in watching those not coppered, he had sometimes noticed an unpleasant effect produced, due to their heating and spluttering. The chemical composition of the carbon points was a matter of great importance, and there were no less than eight or ten celebrated chemists hard at work trying to make electric carbons which should be homogeneous and give a continuous light, but it was a point of great difficulty. The carbons were generally composed of as pure graphite as could be obtained; but, after all, they must go back to the gas companies to get their retort carbons. Carbon points could also be made out of coke; in fact, any pure carbon would do, and the purer the better. The admixture of silica in the slightest degree reduced the illuminating and useful effect, but the addition of oxides of different kinds improved them. Magnesia would increase the lighting effect as 1½ to 1, and antimony still more. But there was certainly a wide field open to any one who would undertake to provide homogeneous carbons for the electric light.

Mr. Ladd said there was one point which might be worth the attention of chemists connected with this subject. In using these carbons the points were converted into the purest plumbago you could find, and could be used as a black lead pencil. Now it occurred to him, if they could get plumbago pencils, they really ought to get better carbons. It occurred to him that it might be possible to pound up pure plumbago, and get better points than were obtained from the retorts.

The Chairman said they were much indebted to Mr. Woodall for so able a statement of one side of the case, especially as the opposite view had been so well advocated by Dr. Higgs. They could not doubt that both these interesting forms of light would be very convenient, but there must be great changes indeed before the facility afforded by gas, where you had the gas ready in tubes, and where by turning on the burners slightly or much you could get the requisite amount of light when and where you wanted, would be superseded. They might well be satisfied to see these two kinds of lighting in use side by side. The more they competed, the better for the public, and they might rest assured that with so many able hands at work on both sides the best possible results would be developed. His own feeling was that each had its own special function to perform. He was very glad that their Society had become the repository of so interesting a record as that which Mr. Ladd had brought before them, and he was quite sure that any little injustice which Englishmen had done to him would now be rectified. He concluded by proposing a vote of thanks to Dr. Higgs for his interesting paper, which was carried unanimously.

SEVENTEENTH ORDINARY MEETING.

Wednesday, April 3rd, 1878; William Hawes, F.G.S., Deputy-Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Crawford, Henry Homewood, 34, Moorgate-street, E.C.
Fuller, William J., Broad-plain Soap Works, Bristol.
Hargreaves, James, Widnes, Lancashire.
Herschel, Julius, M.D., 3, Adelphi-terrace, W.C.
Leverson, George Bazett Colvin, 18, Queensbury-place, S.W.
Manly, Thomas, 74, Park-road, Haverstock-hill, N.W.
Marshall, F. Herbert, Ormesby Iron Works, Middlesbrough.
Smith, Harry Turberville, 9, Great Marlborough-street, W.

The following candidates were balloted for and duly elected members of the Society:—

Bardsley, Joshua, F.C.S., Church-hall, Church, Lancashire.
Bird, W. S., 36, Rathbone-place, W.
Bland, T. F., F.C.S., Stourbridge.
Davis, Walter Charles Hart, Westbury-park, Durdham-down, Bristol.
Nixon, John, Home-office, Whitehall, S.W.

The paper read was—

OUR WEALTH IN RELATION TO IMPORTS AND EXPORTS, AND THE CAUSES OF DECLINE IN THE LATTER.

By Ernest Seyd, F.S.S.

The subject of our diminished exports, or rather that of the increasing deficiencies between our imports and exports to our debit, causes some anxiety. It would seem that in this matter the nation finds itself in the position of an individual, who, be he rich or poor, spends or consumes more in commodities than he sells or produces, and the question is—Do we possess the means for continuing to do so? or are we, as the phrase goes, using up our capital? and finally, what is the cause of the present aspect of the matter?

The subject has been treated in various ways by several authorities, by some in a light-hearted, by others in a heavy-hearted way. I am of the opinion that it has not been treated as it ought to have been, and in asking your indulgence for my method of expounding it, I must first venture to enter upon a short criticism as to the figures stated, and methods of computation adopted by others, so as to make myself better understood.

Firstly, I refer to the returns of our imports and exports, as they are handled by my friend Mr. Stephen Bourne, Assistant Principal of the Statistical Department of the Custom-house, in his excellent and well-known paper on the question. You are aware that our imports are stated at their real value, *i.e.*, presumably such value as they have in the market, equivalent to prime costs and charges on arriving here, as if they were thus invoiced, and this is the true principle of valuation. Our exports, however, are taken at their nett value here without charges of shipping, &c., therefore the difference appears much larger than it really is. I conceive that they should also be stated at their supposed full invoice value, such as would appear at the foreign Custom-houses, as if these followed the same plan as we do here in regard to imports. It is immaterial in all cases whether such charges of freight and other matters are paid by the shipper or the consignee, the question is so far only one of actual equal valuation. Mr. Bourne takes the difference between imports and exports as it appears from the returns, and modifies them in the following way:—First, he deducts from the sum the balance of bullion remaining here as balance of the separate imports and exports of the precious metals. I do not think that these bullion balances are reliable, owing to certain inconsistences in the declaration of value of bullion. The portion of bullion absorbed for jewellery, plate, and in the arts, is limited, and must be regarded as having entered into consumption, and the residue would give us no true amount, unless we were able also to state the exact amount of bills current, and settlements by short exchanges. This cannot be done, for we cannot separate the absolute international trade bills from the legitimate renewals, the pure credit bills, and others less legitimate. Moreover, the import or exports of bullion are connected with money investments abroad, their extension or contraction, an element entirely independent, and at this time, for instance, when British capital invested abroad is being drawn in, the import of bullion is not due to balances on account of commodities. I conceive that the question of bullion is that of the money market, and that in reality the accumulation of gold is shown in the currency, either in the increase of the circulation, or, and chiefly, in the stock of gold bullion at the Bank of England. I shall therefore treat bullion as separated from exports and imports of commodities. Mr. Bourne then deducts the cost of freight from the imports, having taken great pains in arriving at the gross figures involved. But I am of the opinion that the full gross cost of freights should not be so deducted, for they are not profit on shipping; indeed, it may fairly be assumed that only one-third of the gross freights are so. The set-off of victualling stores, which Mr. Bourne adds, does not compensate the matter, the ships' charges afloat and abroad, and other items, must be accounted for. Mr. Bourne adds foreign freights, ships' stores, and coals; but all this can be avoided by treating shipping separately, as I shall do hereafter, and by adopting the simple plan of adding freight charges to our exports, so as to bring them to the same invoice, or real value abroad, as our imports here. From 1854 upwards, although import freights were always higher than export freights, I compute the total of charges, including insurance, commissions, &c., at about 12 per cent. But, for a number of years, the outward freights have still more declined, and commissions have been reduced. This decline set in between 1866 and 1869. Without entering into the details per annum, I think I meet the case fairly, having regard to bulky as well as finer goods, if, from 1854 to 1868, I add 12 per cent., and from 1869 to 1877 I add 10 per cent. to the exports, so as to arrive at the real balance, and submit Table I. (p. 402.)

It must be borne in mind that the reduction in the total of our export is only partially due to the decrease in quantities; the greater portion is due to decrease in value; but, for the purposes of the account, this makes no difference whatever. I propose to use the figures resulting from the table as the nett, or real balances of trade on goods against us.

Secondly, I refer to the method in which this

Table I.—*Showing Imports and Exports at Custom-house valuation and the Apparent Balance. Correcting Exports with* 12 *Per Cent. addition for* 1854 *to* 1868, *and* 10 *Per Cent. for* 1869 *to* 1877. (*In thousands* £.)

	Total Imports.	Total Exports.	Apparent Balance.	Corrected Exports	Real Balance.
1854	152,339	115,821	36,568	129,719	22,670
1855	143,543	116,691	26,852	130,693	12,850
1856	172,544	139,220	33,324	155,926	16,618
1857	187,844	146,174	41,670	163,714	24,130
1858	164,584	139,783	24,801	156,557	8,027
1859	179,182	155,693	23,489	174,376	4,816
1860	210,531	164,521	46,010	184,236	26,268
1861	217,485	159,633	57,852	178,788	38,367
1862	225,717	166,168	59,549	186,108	39,599
1863	248,919	196,902	52,017	220,530	28,388
1864	274,952	212,588	62,364	238,098	36,853
1865	271,072	218,832	52,270	245,092	25,881
1866	295,290	238,906	56,384	267,574	27,716
1867	275,183	225,803	49,380	252,899	22,284
1868	294,694	227,778	66,916	255,111	39,584
1869	295,460	237,015	58,445	260,716	34,744
1870	303,275	244,081	59,176	268,489	34,786
1871	331,015	283,575	47,440	311,932	19,083
1872	354,694	314,598	40,105	346,058	8,636
1873	371,287	311,000	60,282	342,105	29,182
1874	370,083	297,650	72,433	327,415	42,668
1875	373,940	281,612	92,328	309,773	64,177
1876	374,000	255,000	119,000	280,500	93,500
1877	393,900	251,700	142,200	276,870	117,030

matter of our exports and imports, as it is likely to affect our general wealth, has been treated lately by several authorities. The broad questions, What is our general wealth? What are the means of accumulating and maintaining it? and that of, Are we consuming our capital? should be separated in such a way as to enable us to show to what portion of our wealth this may apply. It appears to me that that which has been written on the point, so far, fails in showing this clearly; that the writers have contented themselves with showing our great general wealth, as if they wished thereby to overwhelm the matter at issue, and that some of their statements may mislead us. The question of our imports and exports is, in the first instance, that of our relations with the outward world—outside our home affairs—it concerns what may be called our "international wealth," as distinguished from our home or "internal wealth." Our case resembles that of a rich merchant prince who has his fair piece of land, his mansion, treasures of art, and furniture. He has made his fortune in the home and the foreign trade; it is partly invested in his home possessions, partly engaged in business, and he has a balance represented by claims on other nations, in colonial and foreign bonds, and otherwise. The former, all in his possession here, is the internal, the latter, the external wealth. Now, if such a merchant found that he was losing how would his wealth serve him? He could not export his lands and houses or improvements on his estate, nor could he, whatever the local price may be, sell them to himself, so to speak, as a nation would have to do. His art treasures and furniture it would be unfair to ask him to part with, and money he cannot take from the circulation without re-supplying it, for the demands of the circulation are imperative. He would therefore have recourse to his extra savings, the "external" reserve previously spoken of, and thus realise such portions of his international wealth as may be requisite. The unfavourable state of his international trade may compel him to do so. Under these circumstances he may yet make a profit on his home trade, or even add new improvements to his home estate, but this is not available for external purposes. Whether, when the international wealth is used up, he must have recourse to selling his home wealth, and what the effect of this would be on the price of his property, or the capital involved, remains to be seen. This appears to me to illustrate the present position of this country, subject to our ascertaining whether our international wealth is so declining or not, and from this point of view the statements put forth by others deserve criticism.

In the *Times* of the 7th December, 1877, for instance, there appeared an article on "The Excess of Imports," in which the writer, previous to his explaining the matter attached to the title, proceeds at once to speak of our "wealth," in saying, "The usual accumulations of capital in England cannot be taken at less than £200 millions per annum." He computes this in the following fashion:—

"We know from the income-tax returns that the annual value of house property alone, in the 10 years ending 1875, rose from £69 to £95 millions, an increase of £26 millions per annum, representing an increased capital value, at 15 years' purchase only, of nearly £400 millions, or £40 millions a year. In the same period, the annual value of land increased from £62 to £67 millions, or £5 millions, which represent, at 30 years' purchase, an increased capital of £150 millions, or £15 millions a year."

The writer then goes on to apply the same principle of valuation to railways, canals, mines, and incomes of all sorts, and computes the whole as equivalent to an annual "increase of capital" of, at "a moderate figure," £200 millions a year.

Now, if you bear in mind what I have said before as to this matter of local or national wealth, you may admit that the "capital" here involved is a question of "price" in the first instance, and "price" is a very elastic element indeed. As stated before, if we were obliged to sell such property to ourselves, or among ourselves, what would become of the price and the capital? And if the writer of that article meant to convey that, besides increase in price, there was also a considerable addition in quantity of improvements, the case remains the same. The truth is, that these home possessions, whatever be their quantity, quality, or price, are the requisites accounting for our state of civilisation; they are, so to speak, pledged to this purpose and no other, and must remain so. An actual increase in the number and styles of our buildings and improvements is, no doubt, a gain; but, as far as increased rentals are concerned, there is a set-off. That it is a thing satisfactory to the owner of houses to obtain a higher rent is obvious, and he is so much the richer; but the tenant is so much the poorer. And if you want to apply this both ways, pleased at the tenant's ability to pay rent—thus "eating the apple and having it too"—you might as well say that, when corn is dear and privation prevails, that this is, nevertheless, on both sides, an increase of national wealth.

Surely it must be admitted that such methods of computing national wealth are not suitable; but the tendency of the writer, and the ease with which such tendency tumbles from one phrase into another, must be patent to you when I point out that, in a subsequent part of the article, the writer converts the £200 millions of increase per annum so computed from increased capital into "annual savings of more than £200 millions."

Another method of computation to which I must take exception, is that of stating our wealth by way of capitalising income, as has lately been done by my friend Mr. Giffen, head of the Statistical Department of the Board of Trade. Mr. Giffen takes the income as resulting from the income-tax returns under the various schedules, and capitalises these at arbitrary rates of from 30 down to four years' purchase. It may be admitted that the returns on land and houses under Schedule A, and public funds under Schedule C, give points from which conclusions as to capital may be confirmed, but the items under Schedule B, as farm profits, and under Schedule D, and other statements made by Mr. Giffen, are quite unsuitable for the purpose. Seeing that the purpose of an income derived from mental or manual labour, over and above the mere cost of arrangements or works required, is chiefly that of being consumed, it is paradoxical to say that such incomes can be capitalised, or that such computation can actually be stated as "accumulated national wealth," If Brown makes £1,000 out of Smith, surely that is not accumulated national capital or wealth. And whether this local profit, or credit and debit, is obtained by way of farmers' profits, or by industrial and professional pursuits, or legitimate or illegitimate means, it appears to me that you cannot, therefore, capitalise Brown's advantage by more or less fanciful assumptions of years of purchase. We might as well capitalise the salaries and incomes of our State officers and pensioners, and the expenses of our army and navy, and add such capital to the already existing capital value of property, and the already capitalised incomes of the nation, out of which this is part, and so swell up the amount to any figure we like. It must be obvious to you also, that there are, so to speak, "incomes within incomes," that one large income for one man splits into a number for those below, and so forth. It is a system of wheels within wheels. I need not here enter into a criticism of the various items of Mr. Giffen's estimates, but in order to show you the value of computations of this kind, I may mention that, while Mr. Giffen, in his moderation, keeps every estimate down at the most modest figures, making out that an income assessed of £571 millions a year gave a capital of £8,548,120,000, there was another eminent statist present, who expressed his conviction that the real amount was likely to double that sum. Alongside these figures it must be imagined in how pleasant and gratifying a manner the "fleabite" principle of the National Debt of £800 millions was treated.

The truth is, in these computations the great error is that of confounding and mixing up the real acquisition of property or capital with the means and men which produce it. Before capital or property can be thus treated, the current life of the producing factors must be cared for, and that absorbs the major part of all efforts. In the growth of the human body only a portion of the nourishment turns into flesh and bone; we cannot capitalise the nourishment taken in a year into a mass of flesh, and to complete the phantastical process, capitalise also the "income" which goes in exchange for it. The following plain reflection may serve to show the meaning of this more distinctly. The total income is stated at £571 millions, equal to about £17 per annum per head of population, or less than the cost of maintaining a pauper baby only. But the turnover in business amounts to many thousand millions. The London Clearing-house returns amount to between £5,000 and £6,000 millions per annum, and although they contain many repetitions, yet if we bear in mind how much in banking transactions is outside the clearing, and take the turnover in the provinces, there may be a clear total of from £9,000 to £11,000 millions per annum. Then, there are other settlements by way of account, besides the daily use of the currency, so that a turnover of £15,000 to £16,000 millions per annum is within the mark. This covers more than all the stages of wholesale into retail trade. I may also mention that in Austria-Hungary, for instance, the income of the population is stated at 5,500 millions of florins, or about as much in £ sterling as here, yet the amount of property in the empire is estimated at about one-third of ours, as I shall presently show you. My object in cursorily calling your attention to such figures is that of affirming the suggestion that we cannot mix up the existing stock of property or capital with capitalised incomes, as has been done by my friend Mr. Giffen.

On my part, I shall now endeavour to gain your approval to a system of taking stock of our wealth generally under certain headings, so as to elucidate from that what is real national wealth, and which parts of such wealth are at present being effected by the import and export question. The means of creating and maintaining this wealth will form a separate consideration.

The stock of wealth, in matters of actual free possessions, involving no indebtedness by other parties, in things of value through the adjunct of labour, and in contracts of individual wealth to which the indebtedness of others is attached, may be brought under the following headings:—

1. Lands, the soil of the United Kingdom.
2. Houses, public and private buildings.
3. Moveable household and personal goods, art treasures, &c.
4. The National Debt and other inland stocks.
5. Railways, canals, and public works.
6. Capital in commerce and industry.
7. Currency—gold, silver, and copper.
8. Our "external" or "international" wealth.

In order to bring out more clearly the distinction between these items and our national position in such matters, I ask permission to proceed by way of comparison with another nation. I shall for this purpose select Austria, a State on about the same level of civilisation with ourselves, as a type of a group of nations whose affairs are in a less favourable condition than those of the group of wealthier countries, of which we are the head.

In the United Kingdom the value of lands may be stated at being £2,000 millions. Some portion of the soil is park and waste land, but

against this we can set the very great perfection of our cultivation of agriculture, which gives to our producing lands such high value. But although the amount of £2,000 millions may be given as the value or price for the time being, we must not forget that this price is subject to contingencies connected with general prosperity. It is national wealth, but it confers no special advantage to us over other nations. They also have lands, indeed they would not be nations if they had not. Austria-Hungary, for example, has more acres, and if less cultivated than ours it has climatic advantages. Quantity and quality, together with cultivation and total produce, ought to be considered rather than price. According to best advices, the value of the lands in Austria amounts to £850 millions. It is immaterial whether or not land mortgages are held by resident mortgagees, and we in England have no foreign mortgagees. In Austria, however, where the mortgage system is extensive, so called "mortgage letters," or bonds are issued, of which some are held by capitalists residing out of the empire; the amount so held abroad is not large. Indeed, such lands cannot well be pledged away, unless a nation sinks into a kind of serfdom.

The value of house property in the United Kingdom can be stated at £1,280 millions. The great mass of buildings, especially in large towns, does not excel in solidity, cost of construction, and value; foreign towns, like Paris and Vienna, are far more solidly built. We excel in gentlemen's country seats. The progress made in buildings in England has been very considerable, especially of late years, but it is certain that both in the French and Austrian towns still greater improvements have been introduced. As far as the use and valuation the purpose of buildings are concerned, the same rules apply as in the case of land, and quantity and quality must be regarded rather than price. The value of house property in the Austrian Empire in 1866 was given as £275 millions, but this is the minimum for taxation purposes; at the present time valuation is near £400 millions, and if it were made on the same principles as here it would probably be much larger.

The stock of moveable property consists of art treasures, jewellery, furniture, utensils, all personal possessions of every kind which can be transported. There is no doubt that the wealthiest classes in England possess, individually, more of these goods than those of other nations, whose public collections are more extensive. On the other hand it is certain that the great mass of the people abroad are in possession of more personal goods than the same classes in England. A French economist, well acquainted with England, said to me, "Silver spoons are as plentiful in France as pawn tickets in England," and although this may be an *ex parte* expression, yet there is no doubt that the great strata of people abroad are more thrifty or solvent than ours of the same degree. Household goods and personal possessions of this kind are not subject to foreign claims; they are, even more than lands and houses, pledged to home purposes as a condition of civilisation, although they are saleable abroad at a pinch. Following a rule adopted by other economists, which appears to me applicable to England, viz., that such property may be taken as being equal to one-half of the value of houses, there would be £600 millions for the United Kingdom; for Austria the value of such stock has been stated at £300 millions.

Our National Debt, which, with other municipal loans for which no tangible property is visible, may be taken at £800 millions, is not, as a matter of course, an item of national wealth. It is a contract involving individual wealth on the one, and indebtedness on the other side, grevious to the latter. To the foreigner, however, it is immaterial whether one Englishman owes money to another. The National Debt is an item of consideration for this reason; it represents a portion of the national credit as realised, and in case of necessity we might sell Consols abroad. There has been no need for our doing so, we have raised it and hold the debt, so to speak, among ourselves; but Austria, for instance, and other States, have not only raised part of their debts abroad, but sold other portions of those raised at home, and this begins to show the great distinction between such States and ourselves. The three preceding items of wealth are positive and belong to home life. The National Debt, when held by the nation itself, is a mere item of local wealth and indebtedness by way of a set-off; but when such debt or part of it is held abroad, it becomes an item of simple international indebtedness or national poverty. The public and municipal debts of Austria amount to £407 millions.

The value of our railways, canals, and other undertakings of like public origin and for public use, may be stated at £800 millions. Those of Austria amount to about £260 millions. In matters of this kind we stand at the head of all nations, but they concern our local and internal convenience more than the foreigner. Still, as regards the distinction between States like England and others like Austria, there is again this great difference: we are the stockholders of our own railways, and use their dividends among ourselves to our mutual benefit, whilst a very great portion of the Austrian railways are under foreign advances, part of the stock being held abroad, and this has the same effect upon the Austrian commonwealth as that of their national debt, it increases the "international poverty" of the country. Our railways and public works belong to the sum total of our positive possessions, and though like lands and houses they are not bodily exportable, yet the "stock" may be available for international purposes, if we turn poorer.

The amount of capital employed in the industry and commerce of this country may be stated at £900 millions. I refer to a publication by my brother, Mr. Richard Seyd, who shows the grounds upon which this sum, including the capitals publicly stated, has been arrived at. We must not, of course, understand current money by this sum; the currency in metallic and banknote money is a separate matter, under the next following heading. The capital, as meant here, is either sunk in industrial enterprises, mines, machinery, and other means of procuring or manufacturing commodities; it is represented by stocks of goods ready to enter consumption; some of it is invested in securities, or even in land and houses. It is, therefore, to some extent already mixed up with other home matters. A merchant, for instance, may have a capital of £100,000 invested in Consols, and do

a large business, not with the £100,000 itself, but on the strength of the existence of his Consols, and may employ this credit at home or abroad without investing it out of the kingdom. So insurance companies invest their capitals in properties and securities already accounted for here in the general mass, and do a large business on the guarantee thereof. About one-half of the total capital consists of banking resources, viz., bankers' capitals and deposits. This shares in the general market, and were it not the money of bankers and depositors, but belonged to the mercantile and industrial community itself, if consequently there was no need for bankers, it would stand in the same relationship to industry and commerce as the one-half actually possessed by the mercantile and industrial community.

Trading capital in all countries must bear a kind of relationship to population, production, consumption, prices, and the stocks at home—and for these purposes a distinct sum must be pledged to home purposes, like lands and houses, and there must consequently be a large solid capital in Austria. It is returned to me as amounting to £600 millions, of which £278 millions represents the aggregate capitals of joint stock banks and numerous joint stock industrial and trading enterprises.

Now, we are much in the habit of saying that we have a proportionately enormously larger capital than others, and we refer to bankers' deposits to show this. Our claim to such greater wealth does not rest on such money being used through the agency of bankers and the publication thereof, it is rather due to our freedom from debt and our external possessions. There are many people who think that our capital ought to be larger, that there should not be so much credit. It is true, perhaps, that in France and elsewhere, the actual capital possessed by large and small traders is proportionately larger, and that there is more solvency among the inland traders than here, but our capital used in the manufacturing and international trade is by far the largest. Of the £900 millions capital in commerce, it may be assumed that £500 millions are concerned among the items already enumerated, and this must be deducted, leaving a sum of £400 millions as representing positive wealth in industrial enterprise, machinery, in stocks of goods, and commodities in process of manufacture. For Austria, a sum of £300 millions may thus be set aside.

This country possesses, in gold and silver coin, and bullion in use for monetary purposes, about £135 millions in gold, and £16 millions in silver; namely:—

£107 millions	gold coin	} circulating.
16 „	silver coin	} circulating.
25 „	gold bullion (for the time being in the Bank of England).	
£148 millions of gold and silver.		

Of bank notes we need not give an account; they are not national wealth, and not legal tender abroad. The Bank of England issues notes on the £25 millions (or more or less) bullion, and on £15 millions of securities. Country bankers may also issue £15,800,000 of notes without gold; but these, also, do not concern foreign nations.

In France the total amount of the precious metals, as money, may be given as—

£190 millions	gold coin	} circulating.
85 „	silver coin	} circulating.
50 „	gold	} in the Bank of France.
35 „	silver	} in the Bank of France.
£360 millions gold and silver.		

Over and above its stock of bullion, the Bank of France issues, for the time being, extra notes for (say) £10 millions.

It would, therefore, appear that as far as gold and silver are concerned, we are not the richest nation. But the comparatively small amount of currency used in this country is due chiefly to the higher development of our banking and clearing system, which enables us to do with less cash. Nevertheless, banking and clearing are not neglected in France, and the general better state of solvency in the internal trade of France, and more distributed solidity and wealth, causes a greater natural accumulation of solid money. In this country also we admit only gold as legal tender, and restrict the use of silver to the narrowest limits, whereas in France hitherto both gold and silver have been used for legal tender purposes, the former metal preponderating. Our metallic currency is an item of positive national wealth, and the admixture of bank notes with it is moderate enough to maintain their full metallic value.

In Austria, however (and States in the same category), the case is widely different. Through wars and political troubles, and chiefly through misgovernment and bad economy, the Austrian people have been compelled to export their metallic currency and substitute paper money for it. Of the evils of such issue of bank notes, the necessary over issue, the consequent high premium on precious metal, with their ruinous influence on both internal and international trade, we need not occupy ourselves. Sufficient to say, that the legal tender metallic money is rarely seen in circulation, and only dealt in as a kind of commodity; that the only stock of bullion for the security of the bank note of the National Bank of Austria is held by that institution, and against an issue of £28 millions, amounts to £14 millions. Besides this there is but small silver and copper change, amounting perhaps to £10 millions. Beyond this there is a bank-note issue by the State (apart from the National Bank) without any bullion at its back, of £35 millions. Thus Austria has—

£10 millions in silver and copper change and odd money.
14 „ in gold and silver at the Bank.

£24 millions in gold and silver.

Besides an over-issue of £14 millions of notes by the Bank, and £35 millions (more or less) by the State.

It may here be remarked that countries like Germany, Belgium, Holland, Switzerland, &c., are in a position of metallic parity like England and France, whilst Russia, Italy, the United States, and others, in different degrees of premium on gold and silver, belong to the group of Austria.

The above considered seven items of wealth are internal matters. They are, so to speak, on the soil of the country. Whatever lies outside of this, either in our colonies or in foreign countries, or on the sea, whether alongside or far away from our shores, is external, and falls under the head of "international wealth."

Our "international" wealth consists of:—

Foreign State stocks and colonial stocks.

Foreign and colonial railway and debentures shares.

Industrial enterprises, estates, capital in colonies and abroad.

Ships anchored in our harbours, at sea, or in foreign ports.

Balances of goods, afloat and abroad.

Of the first we held in the year 1872 an amount which may be stated at £650 millions.* In Colonial, Continental, American, and other railways and public works, shares, or debentures, the amount held by us is estimated at £210 millions. Industrial enterprises, estates owned by Englishmen in England, in colonies, and abroad, English capital in colonial and foreign banks may amount to about £80 millions.

The value of our ships may be taken at from £70 millions to £75 millions. Of the 6 millions tons, $1\frac{1}{2}$ millions are small coasting craft, worth but a few pounds a ton, and, estimating the $1\frac{1}{4}$ millions tons of steamers at their respective cost prices, from the highest class at £25 a ton to the best freight boats at £18 a ton, and those of sailing ships from £16 to £12 a ton—making all due allowance for deterioration, which, in some cases, brings the ton to below £5 in value—I am advised on best authority that the capital value of the total of our shipping property is given in the above sum.

Together with the amounts currently owned for goods, the total of our external possessions in the year 1872 may be stated as amounting to £1,100 millions. From this total sum we derived a revenue which may be stated at £65 millions for that year.

France and Germany, besides holding foreign State debts, also hold railway and other bonds, are interested in goods, and have their shipping; but the aggregate is not so large as ours, although that of France is rapidly increasing, and, in its total, may not now fall short of £700 millions.

Austria, however, has no external wealth, with the exception of 330,000 tons of shipping. There are no foreign stocks, or claims of any kind against foreign countries or individuals. On the contrary, Austria is one of the States indebted to the others, who hold some mortgages on her lands, a portion of her State debt, shares and debentures on her railways, and other claims, the total of which may be £400 millions, for which an annual interest of say £24 must be provided.

In order to enable you to see the result of the comparison at a glance, I now submit the following accounts:—

England's Amount of Wealth.

Assets.

1. Lands, say	£2,000	millions.
2. Houses, say......................	1,200	,,
3. Moveable household goods say	600	,,
4. National Debt £800 millions (not to be added)......................		
5. Railways, public works, &c.	800	,,
6. Active capital of £900 millions, of which in goods	400	,,
7. Currency £170 (less bank notes current £22 millions)............	148	,,
8. International wealth..............	1,100	,,
	£6,248	millions.

Liabilities.

1. To foreigners .... £ , 0 millions.

(Our liabilities by way of counter balances of trade, and acceptances of bills drawn from abroad, which may effect the bullion market very seriously, are so far accounted for in our capital and international accounts.)

As regards the above figures, the value of our house property may be subject to discussion upon the question of prices; but so far we may take it that our positive property, free of any claim upon it, amounts to £6,248 millions.

Compare with this now the Austrian accounts—

Austria's Amount of Wealth.

Assets.

1. Lands	£850	millions.
2. Houses	400	,,
3. Moveable goods, &c...............	300	,,
4. National Debt, £407 millions (not to be added)......................		
5. Railway and public works	260	,,
6. Active capital £600 for goods......	300	,,
7. Currency £93 millions (less uncovered bank notes, metallic value	24	,,
	£2,134	millions.

Liabilities.

8. International indebtedness .... £400 millions.

Against £2,134 millions of property, Austria thus has an indebtedness of £400 millions.

In reality, however, the great importance of this international indebtedness is not shown by this full statement. As stated before, lands, houses, moveables, &c., ought to be considered as belonging to home purposes, so that these items would have to be left apart. Railways and public works ought also belong to the category, but as their ownership is practically transferable by bonds, they are so far available. Were it not for this, Austria would be, so to speak, internationally insolvent, as it is now internationally poor and indebted.

Reflect, now, upon the more happy and safe position of the United Kingdom, and you will see

* The total of the State debts of all nations amounts to about £4,500 millions. Of these the following nations, with State debts—England, 785 millions; France 750 millions; Germany, 165 millions; Holland, 80 millions; Belgium, 36 millions; Denmark, 14 millions; total, £1,830 millions—are not only themselves the holders, but in addition to this they are owners of part of the State debts of the following nations:—United States, with 450 millions; Russia, 375 millions; Austria—Hungary, 346 millions; Italy, 251 millions; Spain, 269 millions; Turkey, 215 millions; India, 136 millions; Egypt, 95 millions; Mexico, 79 millions; Brazils, 68 millions; Portugal, 66 millions; British colonies, 63 millions; South America and other small States, 295 millions; total, £2,700 millions. The correct proportion of debts held by the nations themselves is not known, but some of them have placed their entire debt abroad—in any case, the greater bulk is held chiefly in England, France, and Germany. From the last estimates to be obtained, and under reserve, it may be that England thus holds about £650 millions; France, 450 millions; Germany, 400 millions; Belgium, Holland, Switzerland, &c., 100 millions; total. £1,600 millions. Englaod's share is much enhanced by holding the greater part of the debts of her colonies. France has lost largely on account of her payments of £200 millions, but is recovering herself and increasing her international wealth more rapidly at this moment than ever, whilst Germany, with its small internal debt, has always had more room for foreign debts, and the power of the German financial centres of Berlin Frankfort, and other towns is far greater than is currently believed. The question whether the figures here involved are thoroughly true remains open; they represent the case fairly at a given moment.

that over and above of what we possess free of any indebtedness, we have this first reserve of international wealth. Supposing we went backwards in our affairs, and consumed this reserve, we should still be free of debt and more then solvent in our affairs. Before we reached the condition of Austria we would next have to lose our currency, borrow money on our railways and public debt, in succession of reserve or available means. It may here be said—What difference does this make to the common man or to others? People who go to Austria find the residents there walk about in black hats and in as good clothes as we do here, that living there is as cheerful, if not more cheerful and agreeable than here. Little do they know of the abnegation which all classes in Austria have to practice, of the hard work done by the people; and if they appear to be more contented or light-hearted then ourselves, the fault on our side must be sought in the stronger division between rich and poor, and the insufficient or improper education of the latter. Were the division of all this wealth of ours more equal, to the ultimate benefit of the richer classes, as would prove to be the case, and were general education higher, England would certainly contain the happiest population on the face of the earth.

But apart from this moral aspect of the matter, the influence of the international reserve on the home wealth is most marked. It is owing to its existence, in competition, so to speak, with lands, houses, art treasures, and other commodities, that these have so high a value or price to the advantage of their possessors. If this reserve declines, the value and price of such internal property would also seriously deteriorate. Upon the strength of this international reserve, the power of the country, in the political sense of its meaning, greatly depends. I do not urge England to war; but if we could somehow manage to induce the individual owners of our international wealth to give us the half of it, we might, as far as mere finance is concerned, fight wars to the tune of £500 millions, without raising a fresh debt, and yet leave £500 millions of the reserve to spare. Of a total wealth of £6,558 millions, the £1,100 millions international wealth included therein form the outer armour. If, upon the same principle as before applied, we deduct the items of land, houses, and moveables, as pledged to home purposes, we have £2,448 millions, of which £1,100 are international, and if we keep our railways to ourselves, and look upon our capital in trade and currency only as, so to speak, "floating about," we have a total of £1,648 millions, of which the £1,100 millions are two-thirds. This will demonstrate the extreme importance to us of such international wealth.

Upon the system of account which I have ventured to introduce, I think that the affairs of all other nations may be arranged, and the construction of the account appears to me simple and concise enough to be retained in the memory, if you should consent to use the term external or international wealth, as apart from the rest.

If you agree with me as to this method of showing our wealth, you may also agree with me as to the means by which we have acquired—no[illegible]ly our international wealth. The same school of economists, which has promulgated the statements which I have criticised, has said "the loss of income from the entire loss of our foreign trade would be a most measurable and by no means fatal injury." The Japanese, 25 years ago, held similar views, and kept their country rigorously closed against foreign trade, and whilst they have now thrown open their ports, it is rather curious to find that there should be English-Japanese of this old school among ourselves.

It is almost a truism to say that there is no nation whose doings are so much mixed up with the trade of the world as England. True, the lands we see, the bricks and stones of our houses, the trees, and most surroundings, are of British origin, but from the timber in our buildings and furniture to the knick-knacks in the bazaars, from the stocks of wine in the docks to the humble pipe of our workmen, in almost all the departments of consumption of goods we have (in spite of our own great production) a stronger admixture of foreign element than any other manufacturing nation. Our agricultural produce in cereals, potatoes, meat, and provisions of all kinds is valued at £600 millions per annum, but we import no less than £180 millions worth of the same articles. If our own home manufactures still supply the larger share of what we consume—you can as regards these, apply the same principles alluded to before—they are natural to all countries of the like stamp, as pledged to this purpose; but beyond this we are unquestionably the greater consumers of foreign commodities. Then, as regards our exports and the industry founded upon them, it must be evident to you that millions of our population could not live if they had to work only for the inhabitants of the United Kingdom, unless they were fed at the expense of the rich. Of the civilising influences of our foreign trade among ourselves, the continual obligation on our part to keep up our advance in manufacturing, as contrasted with a possible old Japanese policy and its effects, I need not speak. But one thing must be obvious to you: our international wealth as before described could not have been obtained without such foreign trade, and if you have perceived its importance as both extra wealth and armour protecting us, you will also admit that the means by which it has been acquired stand in an equally important relationship to our current doings in other matters. If, according to our income tax returns, our incomes are stateable at £517 millions per annum, if our international trade, both imports and exports, have amounted to £650 millions, you can imagine that the latter must have a considerable share in the many thousand millions of annual turnover spoken of before. I am of opinion, therefore, that anybody who decries the foreign trade of this country, does more than commit a libel upon the power and cosmopolitan destiny of this nation. We are apt to consume and enjoy foreign goods and luxuries just because we have the international strength to do so. Austria, with its weakness in this respect, had, in 1875, reckoned at the exchange of the day, but £48 millions imports and £37 millions of exports.

The economists who have lately thus decried our foreign trade, have concocted the phantastical statements before alluded to, according to which our annual savings are £200 to £300 millions. In

juxtaposition to this, I now tell you that our real surplus or international wealth has increased at the rate of from £10 millions to £30 millions, a year in a steady, non-phantastical way; and if you, consider how this has gone on during the greater part of the present century, you will, no doubt, be satisfied with the large sum of its aggregate as it may stand at present.

And, in connection with the question, How has this international wealth increased? there arises the next, Is it still being increased, is it at a standstill, or is it declining?

There is *primâ facie* evidence that, at the present moment, it is not increasing. Until 1873 we were in the habit, so to speak, of re-investing the £20 millions (or thereabouts) actual surplus in lending it out again. But, for the last five years, no foreign loans of importance, or railway stock, or company capital have been raised in this market. (The Indian loans raised were covered by the Council drafts.) If the usual surplus had continued, we would, consequently, have had a vast amount of bullion on hand. The Bank of England, it is true, has had a fair store of bullion, and so we might think that, at all events, our international wealth had maintained itself; but there are many signs that this is rather due to a partial realisation of our outstanding claims. Many investors are calling in their claims from abroad, and the realisation of capital is a far more telling process than the mere ratio of decline in interest or income derived from the total.

I now submit to you Table II., commencing with 1854, which in the first column contains the corrected balances of our goods trade from Table No. 1. The second column states the amounts of income which we have derived from our international wealth, covering the apparant balances of the first column, and leaving a surplus until 1874.

As regards the items in the second column I must first make the following remarks:—This country, even before the end of last century, has always been on the right side, and possessed a great deal of outside wealth in shipping, colonial estates, and claims on foreigners. Even after the peace of 1816, when the national debt stood so high, there must have been a surplus of such international wealth of from £100 to £200 millions. The great revival following sent goods to all parts of the world, and duing these times up to 1840, larger profits were made in both home and foreign trade.*

From 1840 forward, when colonial estates had declined for well-known reasons, the railway interest abroad engaged our attention, and we became very large holders of foreign railway stock, which, in its turn, was partly replaced by foreign loans. From careful estimates I come to the conclusion that in 1854 we possessed about £600 millions of international wealth, of which from £250 to £300 millions were foreign loans,

Table II.

Showing the annual real balance of trade apparently against us, as per Table I., and the presumed annual income from our external investments, the balances remaining increasing such investments or decreasing the same

In Round Millions.

Years.	Annual balance of goods against us.	Annual international income.	Balances.	
	£	£	£	
1854..	23	37	14	
1855..	13	39	26	
1856..	17	41	24	
1857..	24	34	10	
1858..	8	38	30	
1859..	5	40	35	
1860..	26	46	20	Balances amounting in the aggregate to £532,000,000, increasing our international wealth from £600,000,000 in 1854 to £1,100,000,000 in 1874.
1861..	38	49	11	
1862..	39	50	11	
1863..	28	51	23	
1864..	37	52	15	
1865..	26	54	28	
1866..	28	48	20	
1867..	22	50	28	
1868..	39	56	27	
1869..	35	58	23	
1870..	35	65	30	
1871..	19	67	48	
1872..	9	67	56	
1873..	29	63	34	
1874..	43	62	19	
1875..	64	60	**4**	Balances decreasing our international wealth.
1876..	94	60	**34**	
1877..	117	60	**57**	

the balance consisting of railways, public works, and claims for goods, for at that time the so-called consignment business of British goods was at its height. Our ships were then comparatively more valuable. As far as the annual sums set down as our income from the total international wealth up to 1877 are concerned, I have taken great pains in following up every one of the factors through the series of years, the increasing foreign loans, the coming in of more colonial loans, the purchases of the French and continental bourses of international stocks from us, the various phases of railway investments in foreign and American lines. Then I have applied my business experience to give effect to such changes in the goods trade as I was able to do; made allowance for larger or lesser commissions earned by us as bankers of the world, took account of the crisis of 1857 and 1866; and checked results to some extent by the state of the exchanges and the movements of bullion. A most important item is the profit on our ships. In 1852 to 1856 our ships brought a very large per-centage of profit, up to 20 per cent. nett. At the present time shipping is so depressed that it does not, on the whole, yield 5 per cent. clear profit. I followed out all this through the various phases of decline and revival. The per-centage of total profits on each year's accumulation varies, therefore, and is lower now then ever, although the total is larger. It has taken me some months of labour to arrive at these results in as systematic a manner as I could, so as to avoid the charge of guess work as far as it possibly could be

* These larger profits were made in the home manufacture before the goods reached the ships, so to speak. At that time the home profit on but £20 millions may have been as large as it is now on £100 millions. The competition is now so keen, and trade is so bad, that the profit is much reduced, and for the moment, on many goods, leaves a loss. This matter of larger previous home profits is one of special interest at this present time. The profit on our whole Lancashire manufacture may be only 5 per cent., whilst the profit which France makes on the £120 millions worth of her wine industry alone is much larger. The visitors business of Paris alone gives France an enormous annual profit.

avoided, but I give this explanation of my proceeding, for I want you to understand that I may have made great mistakes, and that other people might proceed in a more effective way. For my part, I am satisfied that I am correct within a few millions per annum, and it must of course be understood that each separate year's result does not give the extreme points of a wave line, for one year runs into the other, and perhaps into the next, so that such wave line must be drawn between them.

It will be seen that according to these figures we reached the highest point of our profits from 1870 to 1872, these being also the years when foreign loans were freely granted—but from 1873 a decline in our exports set in—in 1874 we had but a profit over and above of £19 millions. So far, then, as the table shows, the total definite balance in our favour went to increase our international wealth of £600 millions in 1854 to £1,100 millions in 1874. But in the year 1875, for the first time in the history of British commerce, as far as we can trace it, the balance was £4 millions actually against us. In 1876, this increased to £34 millions, in 1877 to £57 millions.

I fear, however, that I must go further than this. You will see that in the table I still assume £60 millions as the income from our international wealth continuing through 1875, 1876, and 1877. I have done so in order to avoid the appearance of straining the case, but must now bear in mind that in 1873 a special period of defaults of Central and South American States set in, involving up to 1875 a total of £10 millions raised in London. In 1876 Peru and Uruguay followed with £30 millions, and Turkey, with a total of £80 millions raised in London alone, besides what we may have acquired from what was raised on continental bourses and given by the Turkish Government. The total loss of income from these defaults may be between seven and eight millions sterling per annum, and this ought to be added to the other deficit against us shown in the table. I have also refrained from taking full account of the present extremely bad time for shipping, or of the mercantile capital withdrawn from abroad, and I may remain within the mark when I state that our international income of 1877—given in the table as at £60 millions—was in reality but about £50 millions, making the actual balance against us £67 millions.

The case, as it presents itself, shows that we must have paid away during the last three years a minimum sum of £101 millions by way of deduction from our international wealth. Reckoning the defaults of Turkey and the South American States, likely to be a total loss, at former market prices as equal to about £55 millions, we might take as the lowest estimate £150 millions, as the higher estimate (including shipowners', merchants', and other losses) £200 millions, so that our international wealth now amounts to from £900 to £950 millions, against £1,100 millions, in 1875.

This leaves us still at the head of other nations. Nevertheless, the rapid change from 1873 to 1877 must waken our attention. Whether you take the figures I have ventured to supply, or make your own estimates on the import and export statistics, and the losses we have suffered through defalcations of bankrupt states, there is this minus of 1877 as compared with 1873, and it may be fairly pointed out that the "dullness of trade" does not only mean our making little profit in the international trade, but that heavy losses have been made by merchants—losses which they do not care to publish. The number and the importance of our export traders have sensibly diminished during the last three years. I need not refer to the slackness of our industry in important departments, and the losses of capital engaged therein. It is computed that, in Sheffield alone, the capital, of certain concerns has depreciated by 5 millions, and I am afraid that throughout the manufacturing districts the aggregate of losses must be counted by tens of millions. True, so far, our actual home life, with the exception of the distress existing in some districts, shows no increase in pauperism, and the building trade at this moment appears to be more flourishing than ever. That such should be the case, is easily accounted for. Interior progress of this kind is always consequent upon prosperous years, when such contracts are initiated, and, as you have seen, the years 1871-2-3 were very favourable. Money also is cheap at present, and supports such enterprise. I regret to state it, but I cannot help thinking that we may soon see signs which will modify this activity—at all events, it seems to me that we should not rely upon it, when we experience a weakness in our general trade. That a degree of weakness exists, not because of any previous general over-speculation, as in the crises through which have passed before, is manifested by a number of features and events in certain quarters, which indicate what may be called exhaustion—and that is an element which may also produce some kind of crisis.*

I trust you do not blame me for alluding to these subjects; for, however cheerful and hopeful we may wish to be, or have the right to be, I think that, in the figures laid before you, and in the signs as they present themselves, we have, at all events, just grounds for anxiety.

What, then, are the causes of the present aspect of matters? In order to lead to the true cause, let me first endeavour to review the various allegations which have been made, in numerical order, and to show whether they are tenable.

Firstly. When, in 1873, trade began to slacken a little, the cause referred to was the Franco-German war. Strange to say, however, the two years following that war were in reality prosperous. From 1848 upwards we have had the French and Continental revolutions, the Crimean war, the Franco-Austrian war, the American war, and several minor wars. In fact, never has there been

* It may have been pointed out that, although we possess this international wealth of 900 to 1,000 millions as positive wealth, yet we are subject to a liability of from 50 to 60 millions by acceptances held abroad England is the chief international banker still, and foreigners hold large amounts of English accepted bills. Several millions are held by the German, Belgium, Austrian, and Dutch State banks, but French bankers especially hold heavy amounts. The evil connected with this is, that by means of such bills they may withdraw large sums of bullion from the Bank of England, leading to a bullion crisis. Yet we have hundreds of millions of assets abroad. Unfortunately, also, the Bank of England generally tempts foreign markets by very low rates of interest, adopted because of its reserve of notes, which arises from the continual issue of the £15 millions of note issue on securities, under Sir Robert Peel's Act of 1844. As regards this subject, I venture to refer to a paper read by me at the end of last year, "Diagrams illustrating the positions of the Banks of England, France, Germany, Austria, Italy, Holland, &c., with special reference to the Bank of England note issue," published in the *Journal of the Statistical Society*, for March, 1878.

a period so rich in war. Yet our trade steadily increased year by year. In connection with this, although only within the last two years, it was said that the threatening Oriental war caused want of confidence. In former times, when merchants had long-winded ventures at sea, and vessels were liable to capture and blockade, there would have been grounds for such want of confidence; but now, when steamships run, and voyages are much shorter, news travelling instantly, when railways lessen the importance of blockades, and a better international understanding exists, there is little occasion for such apprehensions.

Secondly. It was then suggested that the dullness in trade represented but one of the usual periods; that in the following year it would recover. Refer to our statistics of the last 60 years, and, although they exhibit certain variations between one or two years, yet the increase was steady. The years following the crises of 1847, 1857, and 1866 showed a falling off of several millions, but in the next following again an increase. But now we find that there has been a falling of for four years, getting worse year by year, at an unheard-of ratio, and without any of those causes to which we ascribe crises and ordinary periodical variations.

Thirdly. Then followed the allegation that "things had been overdone generally." Hitherto things were "overdone" at the crises before mentioned. It was then stated that the "overdone" referred to the use of more machinery and over-production. That we are making continual improvements in and additions to our machinery and industry is evident, and for the last 30 or 40 years there has been a steady progress here and elsewhere. But can anyone say, that suddenly, in the years 1873-4, we had made such a start in this as to bring out the results before us? And as regards over-production, that may have appeared so at first from the stocks on hand; in reality, however, the production was not in excess of the consumption it had hitherto met with. During the last two or three years the production has diminished sensibly, and stocks of goods are not excessive. A great portion of our manufacturers have worked half-time or less, or closed works temporarily. The stoppage of public works, such as railways abroad, is one of the most remarkable features. The existing railways pay fairly; there is room for more. Why should the cessation of this kind of enterprise be so sudden?

Fifthly. A favourite allegation is that which ascribes all the mischief to the strikes of the working man. Apart from the question that strikes do not affect much the value of certain commodities in which the falling off has been severe, it has always been held that higher wages encourage consumption and production among the masses. "Strikes" cannot in any case account for the sudden reversal in trade, and at this moment, when wages are again much reduced and prices fallen much below those of 1873-74, there is no improvement nevertheless.

Fifthly. The "competition" of the foreigner was then referred to. Now, if on account of strikes, or for other reasons, the foreigner had acquired our trade, this might seem a legitimate reason. But it is not so. Foreign manufacturing nations complain of badness of trade and falling off of exports even more loudly than we do, and in their turn ascribe it to the competition and cheaper prices in England.

Sixthly. One of the arguments used is that during recent years we have lent but little money to foreigners, who were in the habit of taking large quantities of goods on the credit of loans. I have pointed out before, that, if this were so, we ought to have an enormous accumulation of gold here; but, as that is not the case, the real reason may be rather that of our diminished ability to do so. It will also be found that the defaulting nations were not such large customers of ours as to warrant this large falling off, and that this falling off is especially noticeable with nations in whom we have confidence, or who have no occasion to be debtors to us on such loans.

Numerous other allegations have been made, which, simply or collectively, do not account for the state of things. The newest and most interesting of them is—

Seventhly, that our increasing imports and decreasing exports are due to our free trade policy. To be sure there are some parties who attribute the capacity of the country to import so largely again to the general word "wealth," but this is not worthy of proper accountancy. Others deliberately state that, because we receive goods free, whilst foreigners and some of our own colonies exact a duty, therefore we find ourselves in the present position, and they advocate a return to proportion. I have already pointed out that foreigners make the same complaint as we do, and this shows, *prima facie*, the one-sidedness of the allegation. But the best proof that this is an unsuitable argument for the occasion lies in the figures of table 2, which I have laid before you. Whether you attach strict faith to my figures or not, the general course of our proceedings and annual results bear out the fact that, until 1873, we had a good balance to spare and to re-invest for the increase of our international wealth and superiority. Ever since we became full free traders until then, we have had no motive whatever from departing from that policy, but rather the contrary. It is unreasonable to allege that since 1873 there is a motive for so sudden a change. I will admit that the increased imports are due partly to foreigners forcing goods here, but there is, this year, already a falling off in the imports. I will further admit that our habits are, perhaps, too luxurious. Although I am a thorough free trader, I am aware that such luxurious habits cannot be checked by mere moral suasion, and I am of the opinion that, unless there is soon a better balance between our imports and exports, there is really no other method of effecting this then by a partial return to protection.

But before we propose to initiate so disappointing a policy, permit me here to first point out what I, in conjunction, with many others, deem to be the real or only cause of all this mischief, a cause of which all the other allegations made are but secondary symptoms.

This real cause is the demonetisation of silver, or rather the steps so far taken in this direction. I am perfectly well aware that the mere mention of this subject will rouse the temper of those whose belief in the gold-valuation is absolute, and that here in England, where we have had this system definitely since 1816, the ground for the

consideration of the matter seems unfavourable. Nor is it my intention to re-open the full discussion of the question. I had the honour, two years ago, to read a paper before this Society, entitled "The Fall in the Price of Silver," in which the views of the party opposed to the demonetisation of silver were expressed. I may also refer to the report of the Parliamentary Committee on the question of 1876, and its conclusions as the cause of the fall in silver, and to other works, notably those of the late Monsieur Wolowski, senator of France.

But I may venture here to call your attention to the following facts:—

In 1867-68, when although the legal systems of individual states differed as to gold, gold and silver, and silver valuations, the use of gold and silver was equally balanced in the aggregate by the combination of the laws, there was a question of France abandoning the use of silver, started by the Chevalier school. Monsieur Wolowski (who did me the honour of embodying a translation of my publication on the subject in his works) opposed the step, saying that if, in the then existing state of balance of laws, one of the great nations demonetised silver, the balance would be overthrown, and dire mischief follow. Nothing was done at the time, and things went on prosperously enough, until, in 1872, Germany began to abandon silver, and thus, instead of France, initiated the movement. Monsieur Wolowski, myself, and others, in 1868, or four years before this, predicted that upon such an event the following consequences would ensue:—

1. The international trade of the world would instantly show signs of decline, to the special injury of the countries whose international trade was largest.

2. That public enterprise, such as results in the construction of railways and other beneficent undertakings, would come to a standstill, and that general progress would suffer.

3. That the decline in price would compel countries internationally indebted to depart more and more from the principles of free trade towards a policy of protection.

4. That the nations of the world would first be divided into two principal groups, the one trading in gold, the other in silver, and this would render commerce between them precarious.

5. That throughout the world a fall in prices would take place, injurious alike to owners of solid property and to the labouring classes, and advantageous only, and unjustifiably so, to the holders of State debts and other contracts of that kind.

6. We stated further, that when this time of depression set in, there would be this difficulty, viz., that the causes of this depression would be sought for in all directions; that all sorts of allegations, more or less groundless and phantastic, or of secondary nature only, would be brought forward by the gold valuation school, and that this real cause, the demonetisation of silver, would be neglected until strong signs and distress compelled thinking men to refer to it.

Our predictions were verified to the letter.

Upon what grounds did we found our predictions?

The extent of international trade and business generally depends mainly on the means available to liquidate balances. Hitherto, both gold and silver, in equal proportions, had served for this purpose. But the moment that Germany overthrew the balanee, and compelled other European States to close their mints to silver, that medium ceased to be an effective medium of exchange between the civilised nations. You may say ruthlessly: let nations send something else to each other. But this something, and everything else imaginable, has already been sent, and leaves the balances of trade to be settled by gold or silver only. The latter being restricted and forbidden by law, the trade of the world becomes naturally limited to what can be settled by the stock of gold only. The reciprocity between the total thus possible and the means to effect the balances, rests on scientific principles as well as on the common sense and practice of every business man. Let it now be borne in mind that this effect has been produced, as far as we see it now, by a partial demonetisation only; as this, unless means to redress or stop it are taken, must ultimately become complete, as the advocates of the gold system desire it to become, the effect would be still more violent. It follows, then, that if these steps towards demonetisation of silver had not been taken, the trade of the world would not have declined, but increased with the less copious but still continued increase of gold. It follows further, that if the new discoveries of silver were freely admitted into the general stock of real money, there would be a ratio of increase beyond what we have experienced before 1873.

The almost sudden stoppage of public enterprise, railway making, and other undertakings rests on equally plain grounds. It has always been found —and the experience made since the gold discoveries in 1849 proves this—that the most effective, and the only true way of incorporating an accession of precious metal with the already circulating currency is through large public works and enterprise of that kind; these are engendered, so to speak, by such additions. But when, through the demonetisation of silver, a contraction of the whole stock of money is enforced, it follows that the opposite effect must be produced. On the other hand, if the fresh silver was freely admitted, there would be a great advance in such public enterprise, as well as a general advance in the arts. In the middle ages, shortly after the discoveries of silver in Spanish America, an era of comparative wealth and activity among the working classes set in, which stimulated labour for the production of objects of art in an extraordinary degree.

The great decline in prices, predicted by the bi-metallic school, which is still in progress, necessarily compels certain nations to depart more and more from the principles of free trade. States like Austria, for instance, which, as I have shown, have to pay away a large sum per annum to foreign investors, would be able to do so with greater ease if prices were maintained and silver available. But through the demonetisation of silver, their difficulties to recover specie payments are doubled, and their debt weighs upon them with double the effect. Whereas, with but a moderate tariff they would have been able to liquidate their debt, at least so far as to pay interest without borrowing more, they are now compelled to put on heavier duties. No high-sounding phraseology respecting free-trade can gainsay the necessity for their adopting such a

policy. Although nothing definite has yet been done, still Austria, for example, is about to increase its import duties, and other States will and must follow this course. Are we not ourselves, the very champions of free-trade, now debating whether we should not recur to the policy of protection; or are you of the opinion that the flowing speeches at the Cobden Club dinners will set right our balance of trade? Hearty free-traders as we all are on principle, imagine what would follow if England become again protectionist! There would then be a general race among nations for increasing their tariffs, until international trade, its benefits, and its civilisation were pressed back into the condition of preceding times. The prospect is a sad one. But if silver were not demonetised—if, on the contrary, the fresh supplies were admitted, there would be higher prices, higher production and consumption, and higher prosperity. The State debts would be discharged with greater ease; each nation could develop its own proper and fit resources for mutual exchange, instead of artificially protecting classes of industry which can be carried on more fitly elsewhere; and we, here in England, might find that our prosperity would become greater than ever before.

The division of the nations into two groups is illustrated by England and India. So far the balance of trade has been in favour of the latter country, but the cheaper rate at which more silver than usual has gone to that country does not compensate India for the loss on the great mass of currency. Our exports to India are weakened, and the losses to merchants and others severe, and if, as is not only possible but naturally to be expected, the trade balance should turn the other way, how could India pay us? It will be said India will and must send gold! Every country discharges its international liabilities in the metal of which its currency is chiefly composed, and cannot do otherwise. Now, if we were wise enough to regard India's interest in this matter, and assisted as far as we can in the recognition of silver, we could receive that material from them, use part of it ourselves, and distribute the greater portion over the other nations for the furtherance of our trade generally. We might then succeed in assimilating the Indian valuation to our own.

The decline in the prices of labour is already so serious as to cause and threaten more suffering to the industrial classes all over the world. Next in order must come the decline in the value of land, house, and moveable property, whilst the gratuitous increase of the value of such long contracts as State debts and other fixed obligations is surely a most monstrous and oppressive prospect. All this would be avoided if silver were upheld, and in the greater prosperity of the labouring and solid property-holding classes, the holding of the long contracts themselves would ultimately find their greater benefit.

The above remarks apply only to what may be called the "international" aspect of this matter, but there is an "internal" aspect which requires serious consideration. The demonetisation of silver means that it is to be deprived of its full legal tender character, and that it shall only serve as "change." This necessitates the restriction of tender to a low figure (£2), and the abasement of the metallic value. The consequence is, that the whole coinage of silver must be forcibly limited to perhaps one-tenth of what it would be in full single valuation. It is one of the greatest questions of the entire problem, whether this enforced limitation of the means of exchange is not one of the most crying evils in the countries where silver has been demonetised before, as in England. The classes who principally use silver coin are not only in the overwhelming majority of more than three-fourths; but, unlike the other one-fourth, they have not such facilities as are afforded by banking and other systems of exchange. It is the deliberate opinion of many thinking men that, if the leaders of the democracy were men of wit enough to understand such subtle questions as these, there would be a popular outcry against such fearful injustice—an injustice which lies at the root of many anomalies in the social condition of these and other classes.* Under the threatening final decline of the value of silver, there is a worse prospect before us, the nature of which can be imagined by those who know something of the Mint laws and Mint operations.

But leaving the "internal" matter aside for the present, and referring only to the "international" considerations involved, it may strike you that there is nothing unreasonable in what I have said respecting them. There are £750 millions of gold and £600 millions of silver money—together £1,350 millions—in use in the world. The demonetisation of the latter would aim at destroying by law the use of £450 millions of legal tender money, reducing the total to £900 millions. Now, whether this forcible deduction affects the international trade, or, what may be more grievous still, the internal and most necessitous interests, or both combined, every thinking man will at once here see the true cause of the present depression of trade. Recollect, however, that so far the £450 millions are demonetised only to a moderate extent, viz., Germany has discarded silver, but this silver has been taken up chiefly by India. Yet this movement alone has been sufficient to cause the change in the aspect of international trade; and what the result will be if this matter goes further might be imagined.

Permit me now to submit to you this question:—

Is not the present experience sufficient to entitle us to demand of ourselves imperatively, that we should reconsider the doctrines which have led to these results, and the adherence to which hold out still darker prospects? Unfortunately, here in England, there exists a kind of infatuation as regards the gold valuation which will resist this to the utmost. In the discussion which may follow upon the paper, you will hear one or more well-known voices, who will tell you that all these doctrines have been discussed and settled before; that the pertinacity with which men like myself bring forth this matter again is surprising and disappointing. They will jeer at me; but are you to be condemned to intellectual immobility, the curse of dogma, just because such men are of the opinion that this matter has been settled by others or themselves? I have said before that a full discussion on the subject is out of the question; many minor matters, such as concern the weight of

* The writer of this brought this subject before the Statistical Society, in a paper called "Currency Laws and Pauperism." *Journal of the Statistical Society*, of March, 1871.

silver, for instance, can be dismissed as frivolous; but there are two main points to which I may call your attention.

The saying prevails, "Gold or silver are the standard of value." Hence the controversy about single standard *versus* so-called double standard. It is utterly wrong to say that gold or silver, either singly or combined, form the standard of value. When first national economy became a subject of literature, the economists of the times sought for words and phrases by which the apparent mysteries of monetary science could be stated. At that time they were but little acquainted with the true nature of banking, clearing systems, and international exchanges, and, in the same way as a child makes his first experience with the power of a piece of coin, they hold money as paramount, as the central power of social life, and called it standard of value. The phrase carries a meaning which is quite untrue. The value of commodities depends on thousands of factors and considerations. Modern advance in banking and clearing systems has shown us that, for the greater portion of intercourse, we require neither gold nor silver coin, nor bank-note currency. And beyond the use of the precious metals in settling international balances, that of the interior circulation is confined to a range in which money, of whatever material it be composed, acts in a purely mechanical way, as means of transfer. Nothing whatever warrants the definition that therefore either the one or the other material is the standard of value. You can, however, well understand what influence this insipid saying has exercised upon the controversy, in what grandiloquent manner it has been used to condemn the "two standards," or the "double or alternate standard," and how this must have confused and still confuses the minds of both speakers and hearers. All this grandiloquence, with its false pretence to modern science, and allusions to the "nineteenth century," must fall to the ground, for I have not the slightest doubt that there are logicians in this country who can clearly define the true factorship of money, and show the error or clap-trap involved in the phrase respecting "standard of value."

The other point concerns the denial of the power of the human law or agreement, in other words the demand, to maintain the relative value between gold and silver at a fixed ratio. The opinions of the monometallic parties themselves are much divided as regards this, their special paradox. The views of the extreme or fanatical gold valuation school are well represented by a letter in the *Economist* of the 23rd February last, wherein the writer, alluding to the American proposal for an international conference on the question, says:—"An international conference might, for any practical good that can possibly ensue, be just as wisely summoned to fix the relations between supply and demand, and between all fluctuations of commodities." This is the usual assertion, hitherto applied only to the different valuations among nations, but extended now to the denial of an international understanding. To deny that the human understanding or law has any influence on the value of a thing, means an entire denial of the force of demand; a compromise on the question is impossible, for if this fanatical party admitted that human agreement had such an influence—a partial one only—the paradox would instantly collapse. The extent of this influence may, in the opinion of one, be insufficient; in the opinion of the other it may be deemed more than sufficient, and the practice proves that the latter is right. A serious point of logic is involved in this, all the more remarkable, for this reason:—The extreme party of the gold valuation denies the power of the human agreement to uphold the relative value between gold and silver; but, in order to assert the legal tender force of gold, it has recourse to the human law in order to suppress that of silver, and maintains that, although the subsidiary silver coins are made of a much inferior quantity of metal, yet that the law itself supplies the deficiency. It is to be hoped that men understanding pure logic will take this matter in hand for the sake of humanity, so as to show the utterly false pretence to which this important cause has been subjected.

The more reasonable section of the gold valuation party are ready to acknowledge the partial and even the supreme influence of the demand, if not destroyed by an express law. Dr. Soetberr and others, admit that the variations which have hitherto occurred between gold and silver, are due to the differences in the laws of various nations, and that, if all nations were agreed upon a fixed proportion, there would be no further question of variation, even under the most varying conditions of supply. Let me, therefore, appeal to you to investigate again this seeming paradox and the illogical use made of the human law. If the doctrines founded upon these phrases are erroneous or doubtful, all the edifice built upon them, the theory of the creditors' wrongs and other matters, must disappear, and at least give way to a more reasonable consideration and less fanatic dogmatism

Besides these theoretical matters, there is now before you a practical proof of right or wrong in the problem. It has always been the boast of the gold valuation party that their system would confer great advantages. They pointed to England's prosperity as a proof. Lord Beaconsfield put the matter right to some extent, when, some years ago, as Mr. Disraeli, he said at Glasgow:—"The gold valuation is not the cause, but a consequence of England's prosperity." We cannot run the same course over again, so as to compare the results of the mono-metallic *versus* the bi-metallic systems. England's prosperity is due to other causes then the gold system—the question is rather that whether, under the bi-metallic system, the country would not have done much better, both for its external and internal trade. The reason why England's gold system has not been so palpably unsuccessful is simply that other nations upheld silver by way of set-off. Now that this balance has been overthrown, that the gold system has spread to one or two more nations, where is the benefit?

We see, on the contrary, that decline and damage are the result. When we, the bi-metallic party, predicted this ten years ago, we were laughed at. More than two years ago, requested by the Governor of the Bank of England, I gave my views on the subject, in a letter which the Governor embodied in his report to the Marquis of Salisbury. I stated distinctly, among other matters, that a

great and rapid decline in general trade and prosperity would set in. The Governor of the Bank characterised this view as too "pessemistic." In March, 1876, I also, from this very spot in this room, repeated the same opinion, and gave figures to show the beginning of the mischief. Then, at the end of 1875, the falling off was but four millions, and again I was angrily charged with crying wolf; but I refer you to the results of 1876 and 1877, as well as the prospects of this year, for the practical right. None of the gold-valuing parties have predicted such a result; on the contrary, they predicted the contrary. And if they are now trying everything to blind your judgment as to the real causes of the decline, you cannot do wrong in reserving in your minds a corner for those whose understanding of the whole case is confirmed by facts.

Permit me also to make some remarks as to the personalities concerned in the problem, for this may be of consideration to those who do not care, or lack the wish, to study the matter from its beginning themselves. Of the old bygone economists I will not speak; they had less opportunity of taking a complete survey of matters of exchange than now; and we, the modern thinkers, ought to have sufficient wit to see for ourselves. On the gold-valuation side there are, firstly, men of the stamp of the Right Hon. Robert Lowe, who, faithful disciples of the old schools, and downright Englishmen and Australian, will scoff at such efforts as I have made. Then comes the view of what in the Dutch Legislature was called the gold-fanatics, of which my good friend, Mr. Hendriks is the acknowledged leader, one of his pupils being Monsieur de Parien, the President of the Conseil d'Etat of Louis Napoleon. The strong views expressed in the *Economist* exhibit the method in which he treats the subject. Between and about these representatives of the gold-valuation school there are the general believers in our old economists, bound to be so from patriotic feeling as to our doing things right. It is needless to say that almost the whole of our provincial press, and the general body of those who have taken some interest in the matter, are imbued with the current doctrines as to "standard" and the "theory of fluctuations." One of the most remarkable positions as a monometallist is that of Michel Chevalier. He first advised the demonetisation of gold, then that of silver. At the same time he is the great champion of free-trade. I have shown you before this, that under the present circumstances of our import and export trade, it is, indeed, a great question whether we can alter this state of things, unless we do have recourse to protection in some form or another; and just because I am a hearty and clear free-trader, do I feel the weight and sorrow of this. How will Michel Chevalier deal with this anomaly? When next he attends the Cobden Club dinner, I hope he will come prepared with what in mercantile language is called a *pro forma* account current, and support his grand eloquence with dry figures. Among the extreme supporters of the gold valuation I count few, if any, international bankers. Bamberger, of Germany, is the only exception. But his views are not without reserve; his efforts went principally to protect Germany. The great majority of the defenders of the exclusive gold system are men engaged in other professions than that of international banking, and lack, at the least, that practice in detail which leads the educated banker to the recognition of the highest principles involved in the problem. Yet such persons hold the view that practical bankers profit by what they call the double valuation, a view as untrue as it is insipid.

On the other side stand men, such as Baron Alphonse de Rothschild, in Paris, a gentleman whose education and high views are second to none, M. Rouland, the governor of the Bank of France, and many other eminent persons in France. The governor of the Reichsbank in Germany, of the Netherlands Bank, and many other eminent authorities on the Continent, men of the highest honour, are ranged on the side of the bi-metallic system. In the United States, also, the matter has received attention, and the Legislature has passed the so-called Bland Silver Bill. We here have been told that roguery and villany are at the bottom of this measure, and abuse the Americans for the re-adoption of silver. Is this quite right and fair? Do nations commit such wholesale rogueries without there being a shadow of good right and sound motive in the case? I trust no one will go so far as to maintain this.

And here, just in connection with this American Bland Silver Bill, an opportunity offers itself for doing what is necessary and right. It may be thought that this partial remonetisation of silver in the United States will serve as a set-off against Germany's demonetisation, and restore silver to its former position. (Curious to say, some of the gold school, who deny the power of such legal enactments, hold this view.) This is an error; the American Bill, in its present form, only cripples the matter more, and introduces greater confusion. Besides the restrictions upon the coinage of silver, necessary because other nations coining silver hitherto as legal tender have restricted theirs, the great fault in the Bland Bill is the adoption of the dollar at $412\frac{1}{2}$ grains—making the proportion of gold to silver 1 to 16—whereas the dollar ought to have weighed 400 grains, to be in accord with the Latin Union, and old German, and other valuations of 1 to $15\frac{1}{2}$. It cannot be expected that these other States will alter their millions of coins to suit the United States, and they must continue to close their mints. The "international" usefulness of silver is thereby again destroyed, and the Bland Bill itself carries its own death-sting in the dollar of $412\frac{1}{2}$ grains.

The United States have, however, introduced a clause into this Bill, which provides for the invitation of all nations to an international congress on this point of agreement. Our gold fanatics scoff at this, as a matter of course, and call it chimerical; but I trust that the common sense of Englishmen, and of their Government, will receive this invitation to a congress with respect, and that it will be attended. It can then be shown that, by a slight concession on our part, we may practically maintain our gold valuation. The introduction of a four-shilling piece, of the proportionate value of one to $15\frac{1}{2}$, to remain for the present under the same restrictions as our subsidiary coinage, is all that is required. This piece would well accord with our

Indian silver coinage, being exactly two rupees and two annas in value. Full particulars of this proposal I gave in the paper on "The Fall in the Price of Silver," read before this Society in March, 1876.

I now leave the figures and the statements submitted to your good judgment. That this question is a very subtle one you will admit; in the popular mind those who occupy themselves with matters of this kind are supposed to be men possessing some special leading kind of intelligence. Hence the public frequently attaches faith to the one or the other, without troubling themselves with the full reasons advanced. In this matter I have arraigned against me the majority of our home economists, or believers in the gold-valuation. Some of my friends tell me, however, that in certain works which I have issued on monetary matters, I have given evidence of ability to teach these matters, and that they have profited thereby, not only as regards practical detail, but also as far as higher logical considerations are concerned. I mention this only in order to give you an idea as to an impression which I lately succeeded in making upon a gentleman, of high education and position, who came to consult me upon this matter. This gentleman was thoroughly imbued with the current views of our economists on the point, and had studied their writings on this very question. I represented the case to him pretty much as I have done here, but had more time to do so. The result he expressed to me in the following words:—"I see now clearly what you mean, and fully agree with you. The doctrines held by our gold-valuation school wantonly inflict an injury upon the world, and entail a kind of devilry, the curse of which no one can see the end. I also clearly see that the re-admission of silver into the monetary systems, on an international understanding, would confer an immense benefit to mankind. The alternative is, therefore, a most momentous one." He added further:—"And you, the bi-metallic party, are treated by the gold fanatic school with this sham nineteenth-century phraseology, as if you were mere sentimental, old-fashioned simpletons, and inferior in brain power. If the question of which are really simpletons is to be decided by facts, it is clear that, whilst the exclusive gold party has predicted a benefit to the world, you have persistently predicted the contrary, and the facts support you." The expressions "devilry" and "simpleton" are not my own, nor do I want to use them with any disrespect to my honourable opponents, but they convey that impression which far-sighted, earnest, and liberal men gain on this case, if they investigate it after freeing themselves of preconceived dogmas.

Finally, I say this to you: Yes, the moment is a is a serious one for you and for the world; it either involves the coming devilry of which we now see the first beginning, with all its confusion and misery, or the increased happiness and more general prosperity of the world—as you may consent to let these dogmas conquer, or as you may be willing to take a wider, and therefore more truthful, range.

It has often been predicted, upon historical precedents, that Great Britain may come to a decline of wealth and power. We have hitherto been able to laugh at this, for we were able to point to our statistics in proof of ever-increasing prosperity. And truly that was proof of our progress. What is aim of all life, political and social, the conquests we have made to govern and civilise other nations, the very aim of empire itself, than that of maintaining and perfecting this increase in material wealth, the true foundation of intellectual wealth, and that of civilisation. Why do we sing, "God save the Queen" at our public dinners, but by way of expressing also our satisfaction at our condition, for which we are ever ready to keep our swords sharp. I confess to you that at such occasions a high patriotic feeling for England overcame me, all the more sincere because I had construed for myself the framework and factors of the wealth of this country, as I have endeavoured to picture them to you, and the reasons of their growth and increase. It is this which moved me, in 1867, to take so serious a view of this matter, and to predict its consequences in clear terms. And now, when I see the beginning of these results, the same earnest patriotism justifies me in appealing to you again.

What you have to decide is this:—Will you attach faith to these flat doctrines of the gold-valuation, which in their actuarial dryness are so pompous and seemingly effective to the weak-minded, yet for this very reason so weak of grasp and devoid of life? If, *nolens volens*, you will let them have their course, you may see yourself drifted into a state of things which can scarcely be redressed. There may be temporary revivals of trade, comparing one period with a preceding one, but you will find that the whole tendency will be downward. The fall of empires is generally due to some subtle cause, which instils its poison into the system. In former times, when social science did not exist, such causes were frequently overlooked. I am not dogmatic enough to insist on your accepting my view as to the poison involved in this matter, but there are many among you who may have their suspicions in reference to it. For myself, I hesitate not in saying, and justify this to myself by the picture I have drawn, and all the influences which affect its working—from the international point of view, the questions of free-trade and protection, to the internal considerations hinted at—that this cause, unless it be rescued, threatens the destruction of England's wealth and supremacy with mathematical force, and this is impressed upon my mind with letters of fire.

If, on the other hand, your leading intellects and your statesmen should free themselves of these insufficient doctrines, and all their inferior belongings, if they should gain the right view of what solid currency, its true office and benefit means for both international and internal purposes, and if they should meet this matter in a liberal and business-like spirit, a different result will follow. A proper understanding will do away with the uncertainty in commerce, with all the angry mutual charges of nation against nation. For India it will be of incalculable benefit. For the world at large, it would mean an increase in prosperity and well-being which will throw all previous ages into the shade, and our own Custom-house statistics and general accumulation of wealth might exhibit figures of which our patriotism would have reason to be much prouder than ever.

If you believe me in my earnestness, if, in what I have laid before you and said before I have made certain matters clear, if on the whole, as regards principles, consequences, and facts, I have been consistent, you may believe that I say all this to you because it appears to me as clear as the light of day, by God-given reasons. But if you do not attach weight to what I say, if you remain passive in all this, let me herewith put these views on record, as I did ten years ago in my first publication on the subject, and two years ago on the very spot on which I now stand, and for all the rest I claim your indulgence.

DISCUSSION.

Mr. Hale thought that the fact of the price of silver having advanced since Mr. Seyd read his former paper without any corresponding general improvement, was an argument against his statement that a remonetisation of silver was the only remedy required. He also thought some of Mr. Seyd's calculations misleading, and disagreed with his remarks on protection.

Mr. Dibley said they must feel indebted to any gentleman who should bring before them any reason for the present great falling off in the trade of England, a matter of vital importance to so great a manufacturing nation as ourselves. At the same time, he did not share in the view propounded to account for it, that it was due to the demonetisation of silver, in opposition to which they need only refer to Mr. Seyd's previous paper relative to the depreciation of that metal, the value of which they had since seen rebound again. It was to be hoped that Mr. Seyd would find the main principle he had brought before them answered in a similar manner in a few years to come. It would be a fatal principle to adopt to treat a question of this description solely as an absolute question of free trade or protection. The simple fact was that any course taken by Government must be dictated by expediency, according to the circumstances of each nation itself. Free-trade assisted us when we were able, in the matter of production, to supply the world with goods; free-trade was a very good cry when our machinery was in full operation, and generations of workmen had grown up with a predisposition to habits of industry, for then we could manufacture from the resources placed within this island a vastly larger quantity of goods than were required for our own goods. But, supposing previous to the development of our resources, France, for instance, could have sent coal and iron into this country at a very small rate, so that it would not have paid our capitalists to venture their money in the development of the resources of this country, the result would have been that we should have remained, as many nations remain at the present time, with enormous resources comparatively undeveloped, being able to supply their wants cheaper from abroad than they could manufacture for themselves. But the great question was, what was the cause of the falling off in our exports? It was well known that from 1871 to 1874, through a concurrence of circumstances, the price of production in this country rose to an extraordinary height; in the commodity of iron alone, which used to be purchased for £9 a ton, £24 a ton had to be paid for it. What was the condition of matters abroad? Many nations had within themselves the bases of production; they had coal and iron-stone, but they had no inducement to expend capital to work them, since they were able to import their goods at a cheaper rate than they could themselves produce them. But America, for instance, had now become nearly self-dependent. It was all very well to talk about the effect of the international exchange of silver as if it were a sort of manna to be prayed for to fall down upon us, but, in spite of such fine poetical theories, the fact remained that each nation did the best it could for itself in setting about to develope its own resources, so as to become as far as possible self-reliant. Germany at one time was nearly dependent upon us for her crude materials and for rails, but they were now manufacturing for themselves; they had put an enormous duty upon all articles of British and foreign manufacture, and were even sending steel of very good quality to England, because they could produce it cheaper. It was a well-known fact that the shop windows throughout this country were filled with articles of American manufacture, and agents were continually soliciting orders for American goods which could be produced cheaper in America than here, notwithstanding that the price of our labour had fallen. As a fact, forks used for agricultural purposes were produced there and sold in Sheffield cheaper than they could be made on the spot. The falling off in our exports was not due to the demonetisation of silver, but was the consequence of our having lived in a fool's paradise, and allowed our commodities to attain an unnatural price, and thus induced foreign countries to develope their own resources. How the condition of our export trade was to be improved was the serious question to be considered. The action of Government must always be a matter of expediency, and it was our duty to love our own country best; but they should consider whether the difficulty could not be met by reciprocity, and that was one of the earliest points they should set about to prove.

Mr. Bourne said he had been condemned for stating the balance of trade against England at too high a figure, but Mr. Seyd had put it still higher, and, unfortunately, it did not seem that his figures could be controverted. There could be no question that, since 1872, the balance had changed, and that year after year we had been importing more largely and exporting less, until, at last, it had become a very serious question how to meet the emergency. In former years we exported largely to other countries, and accumulated debts with them, which they were now repaying in food. In the case of America, with which we had a large trade in railway materials, they did not pay in money for what they received, because we were rich enough to give them credit, and were satisfied to take railway and other securities from them, but now they, as large producers of the food we required, were sending it to us, and we were paying them for it by the securities we held. But that was a process which could not go on *ad infinitum*. He quite agreed with Mr. Seyd that the balance against us was now about 57 millions, so that we must have enormously reduced the general indebtedness of the world to England. What was the lesson to be learned from these facts? Mr. Seyd had spoken of the demonetisation of silver, but he certainly failed to see the connexion between the alleged cause and effect, as Mr. Seyd also had failed to show it. That gentleman had further recommended protection; but it was difficult to see how protection would help us at all. Hitherto the loss had certainly not amounted to anything very large, for if the imports were analysed it would be found that food represented in 1876 £159,000,000, while raw materials amounted to £119,000,000, and manufactured articles to £41,000,000. Therefore it was quite clear that up to the present time free trade had not produced a very large amount of competition; but we, through our luxurious living and high rates of wages, had increased the cost of our productions in foreign countries, so that they were now competing with us. If we could induce other nations to adopt free trade, as we had done, the mischief would cure itself; but as that could not be done, we must resort to other means. We had a choice of courses open to us; one, necessity was impelling us to, viz., reducing the rate of wages, and lowering the expense of producing manufactured articles; and the other was that of lessening

our imports, not by any arbitrary law, but by the influence of public opinion. We must cut off articles which were not necessary; and alcohol was ono in which we must very shortly make a very considerable reduction. But the chief point to look to was the development of new markets—leaving the old countries now effete for us, and engaged in all kinds of contests, and going to the new countries which our geographers have been discovering for us. There we should find markets which would again develope our export trade.

Mr. Langley said—I think we all owe a debt of gratitude to Mr. Seyd for what I must call a most valuable contribution to the financial literature of the day, endeavouring, as it does, to fathom one of the most difficult problems of our very intricate civilisation, which, as I believe, is becoming more and more so every day—the result of our increasing numbers and the limited area on which we struggle to earn a livelihood. I need not dwell on the figures as published by the Board of Trade, which, year by year, and more especially within the last three or four, exhibit the extraordinary results of an enormous increasing balance of trade against us, and yet I am somewhat disposed to draw a crumb of comfort from the magnitude of the figures, for the reason that I feel bound to believe there must be some counterbalancing facts, or we should otherwise, with a balance of £130,000,000 against us in 1877, and that an increase over the last and previous years, have been long since drained of every ounce of gold we possess; but, be that as it may, our best thanks are due to Mr. Seyd for having brought us face to face with one of the, if not the most important and difficult questions of the day, and I pay him no undeserved compliment when I assert that his paper deserves the most careful attention of all men engaged in commerce, and that statesmen would do well to ponder and weigh his facts and arguments. To the best of my humble judgment, the most important and most interesting part of Mr. Seyd's paper is that in which he endeavours to trace the cause of the present unsatisfactory state of trade and commerce as shown in our trade returns, but existing more or less in every country of the world, perhaps mostly so in Europe, Asia, and the United States. This cause, Mr. Seyd maintains, is the demonetisation of silver, and to the best of my very humble judgment he is right. I believe he has got the right sow by the ear, and in confirmation of this belief I would particularly call your attention to the predictions made by Mr. Seyd in 1868, when the demonetisation of silver was first discussed; those predictions are verified by the state of things actually now present in a most remarkable way, and although it may be doubted whether demonetised silver is the cause of the present state of things, as predicted, we are bound to give Mr. Seyd's foresight a very large share of the benefit of the doubt; for myself, I believe Mr. Seyd to bo right, but, right or not, the resemblance between his predictions and the actual state of things is wonderfully exact. I anticipate that the effect of Mr. Seyd's paper will give rise to an amicable contest between the advocates of the two metallic schools—the bimetallists and the monometallists—and in view of such a probable passage of arms, I would say that while we, the advocates of bi-metallism, have the broad fact as our base, that the system has existed in France the last 70 years, and still exists, is not abandoned as some would have you believe, and that, therefore, we are eminently Conservative in our desires, our opponents advocate the abolition of a system which we maintain has been mainly instrumental in aiding the prosperity of France and the Latin Union generally. As before named, the opponents of bi-metallism would have you believe that France has abandoned her double system, but this is not the facts; he has suspended her system till March, 1879, and when the law was in progress for this purpose a few weeks back, M. Leon Say stated that reasons were at work which would probably change the whole aspect of the question before the present year was out. This does not sound like abandonment, and no doubt the reasons referred by M. Leon Say were the arguments thus taking place in the United States, on the subject of their restoration of the double standard; and in this matter I would beg to call your attention to a remark by Mr. Seyd as follows:—"If the leaders of democracy in this country had the wit to understand such subtle questions as these, there would be a popular outcry against such fearful injustice" as the demonetisation of silver, and this remark induces me to say a few words on the action of the people of the United States in this matter. In the first place, we must, I think, take it that the re-adoption of the double standard in the Unitad States has been the act of the people, it has not been the act of the Government, but rather the act of the people as opposed to their Government, who were rather largely, and somewhat broadly, not only by tacit but by expressed consent, committed the other way in connection with their funding arrangements. Now, it appears to me, that the people of the United States have had the wit to see that injustice was being done in respect to silver; many arguments used indicate this, and much of the evidence taken before the Silver Committee distinctly proves this. I do not say that there has been no tendency to repudiation, as urged so warmly along the Atlantic States, and re-echoed here. I am sorry to say that I fear there has been more tendency in that direction than there should have been; but I believe, and at any rate I hope, there has been less than appears, and I am more disposed to believe that the American people have had the wit to see the injustice, and by an unrefined common sense, and a reference to their previous history, determined they would have what they always have had—a dollar, and a dollar they have got, of the weight and fineness of their law of 1834, which, they claim, gives them the right to pay in gold or silver. It is true that the dollar of $412\frac{1}{2}$ grains only complicates the question in an international point of view, making the ratio of value 16 to 1, in place of $15\frac{1}{2}$ to 1, as in France; and how the difference is to be arranged it is difficult to see, for no international arrangement can exist except on an equal basis of value. Either the United States or the Latin Union must give way —which, remains to be seen. We have lately been favoured with a paper on the question of the India exchanges and their variation, caused by the variation of silver. Without going into that question, it enables me to remind you of Mr. Seyd's proposal to coin in India a new coin of 2 rupees 2 annas, the equivalent, at $15\frac{1}{2}$ to 1, of 4s. exactly, and this coin Mr. Seyd proposes should be a limited legal tender in this country. This proposal deserves some attention; it would be perfectly harmless, and would touch no interest, and would tend to facilitate an equilibrium in the India exchange. The creation of such a coin would be the exact fifth part of our sovereign, and as such, would lay the foundation of the introduction of the sovereign into India as the exact equivalent of five coins of 2 rupees 2 annas each, at $15\frac{1}{2}$ to 1. Time does not allow of any more elaborate discussion on the silver question, which I feel I have very inadequately represented to your notice. Bi-metallism, you may rest assured, will, like many other important circumstances, assert its rights, and will, sooner or later, if not met and adjusted in a proper and statesman-like manner, make itself felt in a way that will overpass the power of resistance; but on this matter, as we have heard in the old play, "Time Works Wonders," and to time I am quite prepared to leave the final adjustment of this most important question. I cannot sit down without once more offering my meed of praise to the author of the valuable paper which I have just heard read. In that paper the views of the author are clearly and distinctly laid down, and I am satisfied the time will come, and is not far hence, when the financial world will pay to Mr. Seyd the honou

which is his due, in my judgment, for one of the most able papers that have ever been contributed to financial literature.

The Chairman, while seconding the motion, could not agree with Mr. Seyd in his facts or figures, and certainly had not expected to hear protection advocated at this day. They had been told by one gentleman that labour was so cheap in America that American manufactured articles could be sent here to undersell us, while another had said that everything was so dear and duties so high there that they could not send us anything if the cost of production here were lowered; but how high duties in the one case and lowness of rates of labour in the other could produce mischief in both countries seemed beyond conception. It was said we were importing much more largely than we were exporting, but Mr. Seyd had clearly shown that we have a very large amount of international wealth, and that some few years back it amounted to 1,000 millions. Was it extraordinary, when the whole Continent had been in a state of commercial collapse, that in the States of Germany and France for two or three years past there should be a balance of 60 or 70 millions now repaid to us? He thought Mr. Seyd's calculations erroneous, but it was impossible at present to go at length into the facts and his deductions from them.

Mr. Seyd, in reply, said that many of the remarks made in opposition to what he had stated had arisen from the disadvantage of his not being able to read the whole of so long a paper. This was not a question of the recent increase in the price of silver, but of its cessation as a medium of exchange. Adhering merely to the principle that silver, whatever its price might be, should not be debarred as a medium of international exchanges as it had for the last 6,000 years, he had come to the conclusion that if it were trade must suffer. Hitherto £1,300,000,000 of silver and gold had been used in the world, and if the demonetisation of silver threatened the loss of £600,000,000, or any portion thereof, the international trade of the world must suffer. Ten years ago the necessary consequence of silver ceasing to be an international medium of exchange had been pointed out. That was the deeper cause which Mr. Langley had clearly recognised, but which the gentleman who regarded the question from the food point of view had been unable to see; but they must enter into the whole theory of the matter in order thoroughly to understand it. The subject was one which involve great questions of logic; and we must go back to these great considerations, when other matters and features of the race would show their secondary character. Besides this international problem, there was an "internal" problem connected with it, perhaps of greater importance; but until men of thoroughly logical inclinations and capacity took this in hand, there would be no chance of the subject being properly appreciated, and the effects would be mistaken for causes. He had been quite misunderstood on the subject of protection, for he distinctly stated in the paper that he was a free-trader. Though the most brilliant eloquence might be used in favour of leaving things alone, any grocer in the City of London would be able to answer the eloquence with these figures. What was the use of appealing to Chevallier's statement that free-trade was the "grandest thing in the world," in the face of those figures? He did not stand alone in alluding to the necessity of doing something. Lord Bateman had lately, under the plea of raising the £6 millions, advocated "reciprocity," a subject ably treated, Mr. J. T. Pim, of Dublin, avowing himself a hearty free-trader, but a proof of the confusion under which we laboured. Mr. Dibley also advocated "reciprocity," another term for "protection." What he wanted to point out was that this tendency to advocate a return to protection had been predicted by him 10 years ago as a necessary consequence of the demonetisation of silver. And he did not advocate protection now, on the contrary, he hoped that logical inquiry into the problem would lead others to see the real cause of the present anomaly, and that they would act accordingly, so as to avoid the need of protection, and return to free-trade principles. Mr. Dibley's allusions to the importation of American goods served to show how the demonetisation of silver affects the international trade. America is a large producer of silver, but she cannot use this freely for payments to us. Hence she is forced to create a set-off by forcing her industry beyond measure, and that illustrates also the position of other States. But if we could take £10 or £12 millions of silver, our trade with America would not only increase in that measure, but we could part with the greater portion, on a safe basis of contract, to India and other States—and all the beneficial ramifications following thereon, now destroyed, would not only again become operative, but increase in extent. Another speaker had said that every nation must have its own development. Granted. If the depression in our trade was due to such progress made by foreigners since 1873, it stands to reason that these foreigners ought to have obtained our portion, and be the more prosperous, but the fact is, they suffer as we do from depression in international and internal trade. Mr. Dibley had said that our prosperity and prices a few years ago were too high. The mercantile principle is, that we should make profits, and so we have honestly acquired our wealth; it was a matter of regret that people will try to explain such loss of profit by such phrases, instead of showing willingness to inquire into the principles pointed out. If this inquiry took place, the mysterious cause of all the mischief would soon be more manifest to all. In conclusion, whatever might be the right view of the question, the fact existed of the sudden decline of business all over the world; England was not affected alone, and that this decline, so sudden and surprising, set in at the moment when silver began to be diminished by Germany. The speaker ended by saying:—Admit at least, that we, the bi-metallists, clear in our conclusions ten years ago, predicted this decline. You may puzzle your brains regarding other possible causes without finding them definite, and you may therefore place some confidence in people whose predictions of evil become true. You might therefore place equal confidence in our predictions of good, and believe me when I say that if proper steps were taken for the proper use of silver, there would be greater prosperity than before. If in 1872 our exports amounted to £315 millions, which have, through this cause of demonetisation, declined to £251 millions. I allege that if this cause had not existed, or if we had done our moderate share in upholding the use of silver, we would have seen an increase to £400 millions, or beyond. What this would mean for our wealth, and the welfare of the world in equal measure of development, and for the future, I leave you to imagine; but, with this choice between evil and good before us, I trust that you will respect the efforts I have made on behalf of this country and humanity at large.

Dr. Leoni Levi writes:—

My friend, Mr. Seyd, in his paper on "Wealth in Relation to Imports and Exports," endeavoured to show that a serious calamity is impending on England from the fact that whilst up to 1874 the portion of national income derived from what he calls "International wealth" was greater than the excess of imports over exports, since that year the latter has far exceeded the former, or in other words, that instead of the excess of imports being paid by income, it is now being paid by trenching upon capital. I am of opinion, however, that the data upon which he bases his calculations are not very reliable. The balance of trade is not really deducible from the amount of imports and exports as valued by the Customs. There are freight and profits to be deducted, due in great portion to British

shipowners, and no end of items on both sides, which should be taken into account before any balance of indebtedness can fairly be arrived at. Generally speaking, an excess of imports over exports is a sign of prosperity, not of declension. Is it a misfortune to an individual that his income exceeds his expenditure? Surely not, and neither is it to a nation. The greater amount of excess of imports for many years past arises from the fact, that whilst England is becoming richer, other nations relatively are becoming poorer, and having no other means whereby they may pay their debt, they do so by sending hither goods and produce in great quantities. If it were not so, would not we see great exports of bullion if not of merchandise, and would not the exchanges be all against England? What precise amount is due to England, from what Mr. Seyd calls "International wealth," we have no means of knowing, and therefore it is not in our power to fix any exact relation between what is to be paid for produce, and what we are to receive on other accounts. Some of our friends are very anxious respecting this mysterious balance of trade. The phantom is raised again and again to frighten and scare the uninitiated in its secrets. For many years past the cry of distress has been very loud, and I have again and again been told that three years ago the nation was living on faith, two years ago on hope, and this year on charity, yet I find that all this while property and income paying income-tax are becoming greater and greater in value. They say that trade is ruined, but an exportation of £200,000,000 worth of produce and manufactures a year is far from indicating ruin and prostration.

Mr. Seyd's remedies are, I fear, worse than the disease. A return to protection would not increase national wealth. It would cripple production, impoverish the people, dishearten trade, and diminish national resources. That will be its pure work. And as to the adoption of a double standard, what on earth has that to do with restoring the balance of trade? The question of a single or double standard may fairly be debated in connection with coinage, though I think no debate is needed in a matter which of necessity settles itself, and that in favour of a single standard, by which all other commodities may be valued. But let us not import an irrelevant matter into a question of quite another order.

Mr. Seyd writes:—Having seen Dr. Leone Levi's letter on my paper, I venture to point to his remarks as a sample of the manner in which such matters are treated by gentlemen who were not present at the reading of the paper. Dr. Levi says that our import and export statistics are not reliable on account of freights and charges, as if I had overlooked this, and not stated distinctly, in several paragraphs of my paper, how I correct this, even criticising at length Mr. Bourne's computations, and submitting a table with these corrections. I have not predicted any dire calamity to England, but submitted figures tending to show how our wealth is affected, and Dr. Levi, instead of indulging in this off-hand criticism, might have done better if he had submitted an original statement of his own. As to the remedy, and its connection with the question of gold or silver or bi-metallic valuation, I am aware that Dr. Levi belongs to the extreme gold party described in my paper, and cannot possibly see that which to many others appears as the most important feature in both international and internal trade. Dr. Levi makes it appear that I advocate a policy of protection, whereas, in reality, I simply point out why the cry for protection is raised—to my great regret, as a free-trader.

The number of reapers and mowers sent out from a single American works, those of Mr. W. A. Woods, at Hoosac Falls, since 1853, when the works were commenced, is 277,027, and of these 107,551 have been made since 1873.

MISCELLANEOUS.

THE INVENTION OF THE REAPING MACHINE.

It would appear that though the claim of John Common to be the inventor of the reaper* has been practically ignored up to the present date, yet an attempt was made, not so very long ago, to obtain for him the credit which appears so justly his due.

Mr. G. H. Thompson, to whose inquiries on the subject, addressed to the Secretary, is due the publication of the extract from the Society's Committee Minutes in the *Journal* of a fortnight back, now writes to give the particulars which he has been able to ascertain by inquiries in the district. It will be seen that his communication contains much information which is certainly new, even to many who have made a special study of the subject. Mr. Thompson writes as follows:—

Sir,—I am induced to write to you through having lately seen an extract from a letter addressed to the *Daily News* by Jas. Howard, Esq., of Bedford, respecting the origin of most of our agricultural implements. It is common enough to find credit given to Americans for them, but Mr. Howard, a very competent authority, asserts "that the best agricultural inplements have originated in the United States is not only not true, but the reverse of the fact, with the exception of the reaping and mowing machine (and these are not exceptions in any strict sense of the word). Among the great variety of machinery now in use, England is not indebted to America for a single idea." It is to this apparent exception that I wish to draw attention.

In this neighbourhood, it has been looked on as a settled fact that the main features of the reaper as now in use were the invention of a clever mechanic, resident in the village of Denwick, about a mile and a half from this town, John Common, a millwright by trade. For the reasons of this belief, I send you a copy of the letter which he addressed, in the year 1860, to the editor of one of our local publications, the *Alnwick Journal*. It was published at the time of his death in 1868, along with the extract from the MS. of the Society of Arts, and the statements contained in it have not once, to my knowledge, been questioned. At one time Ogle was considered the inventor, and the idea of constructing a reaper is said by Common himself to have come from Ogle; but the latter does not seem to have made, as Common did, a machine with angular knives, and which McCormick used in the construction of his. A woodcut and description of Ogle's machine appeared in the *Mechanics' Magazine*, No. 110, November 12th, 1825, 14 years after Common had tried his, and the knife as shown has a plain straight blade. Ogle, in his letter, does not even allude to Common, but his silence may not uncharitably be ascribed to a desire to obtain for himself any credit that might be due to the invention. Common's letter is transparently candid and honest.

In the *Alnwick Journal*, of November, 1860, there was published a copy of the extract from the Minutes of the Society, which you obligingly sent me, and which I find was again published in the *Newcastle Chronicle*, of July 8, 1876. In a letter to Mr. Common (1860), from the Secretary, Mr. P. Le Neve Foster, he says, "the model is not forthcoming, as it was not the custom of the Society to keep models of inventions for which no reward was bestowed;" and further he adds "it is very remarkable to observe that the principle now used is distinctly that which you adopted in 1812."

It may interest you and your readers to know that

* See *Journal* for March 22 last.

there is yet living one witness of the trial of Common's machine in 1811, namely, the "John Thew" who signed the certificate, and is mentioned by Common. He is now 86 years of age, a fresh, hale old man, with a very vivid recollection of an event which happened a good deal more than "sixty years ago." He resides at Newton-on-the-Moor, a few miles from this; and on my first visit, in answer to my question, "did he recollect anything about Common and his reaper," he proceeded to describe the machine, its angular cutting knives, &c., and that they tried it by moonlight. The knives, he thinks, were only made of iron, as steel ones were difficult to make or procure, so that the "little something" that hindered its continued working may very easily have happened.

From all this, I think it may safely be asserted that the idea of making a reaper was suggested by Ogle to Common; that the latter worked it out, in its main features, as it now exists; that Brown carried the patterns to America, when McCormick obtained them, and, improving the mechanism, brought it over to England as an American invention. It is, however, of English origin, and unquestionably Northumbrian, and belongs to the Denwick millwright, John Common.

He was remarkable for other inventions besides the reaping machine. He received a silver medal and ten guineas from the Society of Arts, and twenty guineas from the Highland Society, for his invention of the double-drill self-acting turnip sower. I have a letter before me from the Society of Arts, May 23, 1844, informing him that he has been awarded their silver medal for his plan of putting new roots to old trees. In numerous other ways his mechanical talent manifested itself, especially in improving machinery and implements connected with agriculture. That his title to the invention of the reaper should have been so completely overlooked, except in this neighbourhood, I can only account for from this fact, that it never formed the subject of even an unsuccessful patent.

I shall be glad if you can make room in your *Journal* for Common's letter, as it speaks for itself.—I am, sir, your obedient servant, G. H. Thompson.

To the Secretary of the Society of Arts.

The following is the letter of John Common, forwarded by Mr. Thompson:—

Sir,—So much has been said, and a great deal of it untrue, about Ogle's, and Brown's, and Common's reaping machines since the exhibition of McCormick's at the Great Exhibition in London in 1851, and more particularly as a society has recently been formed among our Northumberland farmers for the trial of reaping machines, I feel called upon to state all the facts within my knowledge respecting their original invention in our own neighbourhood.

About the year 1803, I was at Fleetham setting up a new thrashing machine for Mr. John Ostens. Mr. Ogle was then schoolmaster at Newham, and as a reaping machine had been mentioned in the newspapers as having been tried in the south of England some years before, it had been long in his head; and as he and I had been long acquainted, he came down to Fleetham, and desired me to go with him to Newham, and help him to contrive a machine. His was on the rotatory plan at that time, and he could not find out one to cut like a scythe. I gave him my idea of a plan, which he thought well of, and we parted. I understand that he subsequently got Mr. Edward Gatis, a cartwright in Newham, to make a model of his machine; but whether it contained any improvement I do not know, as I never saw it; but I believe it was never tried further than as a model. A few years afterwards he made a second model; but I never saw it, nor ever heard of it, till told of it by his son about 40 years afterwards.

My own machines were all clippers. The first I made was a small one, and the shears were driven by a crank, but it had no apparatus on it for delivering the corn. As far as I can judge, it was made in the year 1811, eight years after Mr. Ogle's first, and tried in secret at night, in company with Mr. Thomas Appleby, amongst my own ripe corn, and it appeared to him and me to answer well. I don't know the night, but I recollect the moon was eclipsed. After this Mr. Ogle came accidentally into my shop, and on seeing the machine, he looked at it, and felt it with his hand, and asked me if it was not for shearing corn, and I said it was, and after further conversation he advised me to let the Duke know about it, and I did so.

Now my second machine was made on the same model by desire of the late Duke of Northumberland, when he was Lord Percy, to send to a society in London, I believe it was the Society of Arts. I delivered it to his Grace, according to my books, on the 5th of May, 1812; and, after his Grace sent it to the Society, they sent him a letter, saying they could not give a premium for it until further trial was made, and no doubt the Society has the model yet. It was made to clip the corn, and to deliver it with rollers into a swathe, as many of them have now, and to be worked or drawn by horses, walking alongside of the corn, but whether it had a fan to bring the standing corn to the knives or shears, or not, as many of them have now, I have forgotten, but it is certain my third one had.

My third and last machine was made in 1812, the same year as my second, in full size, and to be drawn or pushed by men, by desire of the Duke. The shears were driven by a sparrel instead of a crank, and it delivered the corn into a swathe, by an endless sheet moving over two rollers, and it had a fan to bring the corn to the shears. It was tried in Denwick, in Mr. John Thew's field, called the Havers, and it did its work so well, that it surprised the people who were present, but a little something at last happened with the shears that stopped it, as might likely happen with any new machine. A few days after I got it a little righted, and tried it again at the Broomhouse, with like success and accident; so that I gave it over, as it had cost me a great deal of trouble and money. When I made this machine, I gave Mr. Brown, of Alnwick, some patterns of it to make of cast iron, but as he was unable to cast them, he made them of wrought iron, and these he seems to have taken to America with him.

In 1817, Mr. Ogle made his third and last. It had a straight-edged plain knife driven by a horizontal crank, as my second was; and this is the same machine that has been so much spoken of as Ogle's, Ogle's and Brown's, and mine.

Ogle took his model to Mr. Brown, who being a very ingenious man, made a better one of iron, but I never heard of any improvement he made to the cutting part of it. They tried it at Southside, and many people said it answered very well. After the trial at Southside, Brown added the delivery part to it. It was then tried at Broomhouse, but I did not see it at work, for when I went to see it in the evening it was getting dark, and the trial was over.

In 1830, Mr. Brown and all, or nearly all, his family emigrated to America. I heard little or nothing about them till after the London Exhibition in 1851, where McCormick's American Reaping Machine was exhibited. A short time after, two of those reaping machines came through Denwick to Howick, to which place I went to see them, and was much surprised, for they were exactly like the one I had made 40 years before.

These machines were examined at Alnwick, and some people, and particularly Mr. James Eadington, of the Flint-mill, and Mr. James Clark, of the Broomhouse, said they were the very same as my machines.

A year or two after the exhibition, Mr. John Nichol, Mr. Brown's son-in-law, met me at Alnwick Fair and said to me, "You are the very man I want to see." At that time I was in company with Mr. Robert Nicholson, of South Charlton, cartwright. He said his wife had

come from America, and told him that her father had given my patterns of the reaping machine to McCormick, and made a bargain with him, that if any money was made by it, he (Brown) was to have a share of it. Brown died at the time of the Exhibition; McCormick refused to abide by his part of the bargain, and there was likely to be a law-suit about it.

At a subsequent interview in the March of the present year with Mr. and Mrs. Nichol, at South Sunderland, Mrs. Nichol said McCormick came to her father and questioned him about the reaping machine; and after they had conversed together, Brown told him he was then an old man, and that the machine was of no use to him then, and he would let him know all about it. So he went upstairs and brought down the knives, &c., and gave them to him—my patterns and plans, as Mr. Nichol told me at Alnwick, as is clear from the fact that Ogle's machine had a straight-edged plain knife, and McCormick's was a clipper.

Such is the history of the reaping machine in this neighbourhood, and its connection with the American reaper. If I have stated anything wrong, I shall be glad to be corrected,—I am, sir, your obedient servant,

John Common.

Denwick, July, 1860.

CORRESPONDENCE.

STATE AID TO MUSIC.

Though, for reasons I need not trouble you with, no longer a member of the Society, I had the opportunity of attending the meeting last Wednesday, and hearing Mr. Alan Cole's excellent *resumé* of what is done abroad to cultivate musical talent as contrasted with what takes place in this country. May I ask the favour of a small place in the *Journal* to draw attention to one very striking point in Mr. Cole's paper, which, as it seems to me, was overlooked in the meeting? Whilst we give a miserable driblet of £500 a year to the Royal Academy of Music, and nothing to the National Training School for Music, supported entirely by private funds, with a building provided by the munificence of Mr. Freake, it appears that the nation actually spends £96,000 a year in subsidising the inspected elementary schools, under the pretence of teaching music, no music, so far as my experience goes, fortified by the reports of Mr. Hullah, being taught at all in these schools. A certain amount of singing a few hymn-tunes by ear is gone through, and if this be reported as satisfactory, the school gets a grant of 1s. a head. Music, as music, is not taught at all. Nothing is done for bringing forward those endowed with special musical gifts. Nothing is done to bring to light our latent musical talent, which exists quite as much among the humbler classes as among the rich. The money is simply a means of subsidising the schools with something additional under the sham of promoting musical talent. One-tenth part of this money applied duly to the support of national institutions, where those possessed of natural gifts, but unblessed with wealth, might receive first-rate training, and where their talents might be cultivated, would do more to promote music than all the rest of the grant, scattered as it now is broadcast, uselessly under the sham of promoting music. Here is a fund which can be fairly applied with a prospect of usefulness without any additional taxation, and the remaining nine-tenths might, and ought to be, saved, or, at all events, if not saved, might be applied to some better educational purpose than the sham of teaching music.

April, 1878. A Former Member.

PLAGUE OF MICE.

I noticed in the *Journal of the Society of Arts* for March 29th, under the head "Plague of Mice," one of the correspondents desires a remedy for their destruction. Might I be allowed to suggest the introduction of some genets? I glean the following remarks from a recent edition of the "Treasury of Zoology" relative to this animal:—"It belongs to the weasel tribe, and has a very beautiful soft fur. It is easily tamed, and of a mild disposition. The genet at Constantinople and other parts of the East is domesticated like the cat, and is said to be equally if not more serviceable in clearing houses of rats and other vermin. It is a native of the Western parts of Asia, and is also found in Spain."—

John Colebrook.

17, Walton-place, Chelsea, S.W.,
March 30th, 1878.

GENERAL NOTES.

Steam for Heating Purposes.—It is stated that a company has been organised in New York to supply steam for heating purposes. Three miles of street mains have been laid, and at present upwards of forty large buildings are heated by the system of pipes, which derive their steam from one boiler 5 ft. by 16 ft. in size. The pipes run through fifteen streets, and over 1,000;000 cubic feet of space is warmed by the steam, which is supplied at a pressure of 30 lb. to the square inch. The steam, in addition to heating purposes, can be used for cooking food, washing clothes, and extinguishing fires. In addition, the hot water from condensed steam is furnished to the houses through the same pipes. The cost is said to be much less than that of ordinary fuel.

NOTICES.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at eight o'clock.

April 10.—"A New Method for Producing Cheap Heating Gas for Domestic and Manufacturing Purposes." By S. W. Davies, Esq., A.R.S.M.

May 15.—"Dietaries, in their Physiological, Practical, and Economic Aspects." By R. M. Gover, Esq., M.R.C.P.

May 22.—"Controlling and Connecting Clocks by Electricity." By Frederick J. Ritchie, Esq.

African Section.

Tuesday evenings, at Eight o'clock.

April 30.—"The Progress of Agriculture and Stock Farming in the Colony of Natal." By Peter C. Sutherland, Esq., M.D., Surveyor-General of the Colony. The chair will be taken by J. A. Froude, Esq.

Chemical Section.

Thursday evenings at eight o'clock.

April 25.—"The Purification of Water by Filtration." By Gustav Bischof, Esq., F.C.S.

May 9.—"Some Recent Improvements connected with Alkali Manufacture." By James Mactear, Esq.

MAY 25.—"The Position of Chemistry in a System of Technical Education, as illustrated by some of its applications." By J. M. THOMSON, Esq., F.C.S., of King's College, London.

INDIAN SECTION.

Friday evenings at eight o'clock.

MAY 3.—"The Telegraph Routes between England and India." By Major BATEMAN-CHAMPAIN, R.E.

MAY 17.—"Agriculture in India." By F. C. DANVERS, Esq.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock. Third Course, for the present Session, will be on "Some Researches on Putrefactive Changes, and their Results in relation to the Preservation of Animal Substances." By B. W. RICHARDSON, Esq., M.D., F.R.S. The First Lecture will be delivered on Monday, April 8; the dates for the remaining Lectures will be as follows:—April 15; May 6, 13, 20, 27.

APRIL 8.—LECTURE I.

Preliminary review of the subject.

Members can admit one friend to each lecture. Books of Tickets for the purpose were supplied to all the Members at the commencement of the Session.

MEETINGS FOR THE ENSUING WEEK.

MON.....SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures). Dr. B. W. Richardson, "Some Researches on Putrefactive Changes, and their Results in Relation to the Preservation of Animal Substances." (Lecture I.)
Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. 1. Capt. B. W. Gill, R.E., "Travels in Western China, and on the Eastern Borders of Thibet." 2. Mr. T. W. Goad, "The United States' Topographical Survey of New Mexico."
Medical, 11, Chandos-street, W., 8.30 p.m.
London Institution, Finsbury-circus, E.C., 5 p.m. Prof. R. Bentley, "The Eucalyptus Globulus."

TUES....Royal Institution, Albemarle-street, W., 3 p.m. Prof. Garrod "The Protoplasmic Theory of Life and its Bearing on Physiology." (Lecture XII.)
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. E. Bazalgette, "The Embankments of the River Thames."
Anthropological Institute, 4, St. Martin's-place, W.C., 8 p.m. 1. Mr. Francis Galton, "The Composite Portraits made by combining those of many different persons into a Single resultant Figure." 2. Mr. M. W. Flinders-Petrie, "Inductive Meteorology." 3. Mr. E. Burnet Tyler, "The Game of Patolli in Ancient Mexico, and its probably Asiatic Origin."

WED....SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. S. W. Davies, "A New Method for Producing Cheap Heating Gas for Domestic and Manufacturing Purposes."
Graphic, University College, W.C., 8 p.m.
Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m.
Royal College of Physicians, Pall-mall East, S.W., 5 p.m. (Lumleian Lectures). "Insanity in its Legal Relations." (Lecture II.)

THUR....Institution of Naval Architects (at the HOUSE OF THE SOCIETY OF ARTS). Morning Meeting at 12 a.m. Annual Report of the Council. Address by the President. 1. Mr. B. Martell, "Steel for Shipbuilding." 2. Mr. W. H. White, "The Comparative Efficiency of Single and Twin-Screw Propellers in Deep Draught Ships." 3. Mr. W. Froude, "The Elementary Relation between Pitch, Slip, and Propulsive Efficiency." 4. Dr. Woolley, "The Theory of Deep-Sea or Oscillating Waves." Evening Meeting, at 7 p.m. 1. Mr. W. Denny, "Lightened Scantlings." 2. Mr. J. Wigham Richardson, "The Load Line of Steamers." 3. Mr. H. H. West, "The Application of the Decimal System of Measurement in Practical Shipbuilding." 4. Captain Goulaeff, "The Nicolaieff Floating Dock."
Royal, Burlington House, W., 8½ p.m.
Antiquaries, Burlington House, W., 8½ p.m.
Institution of Mechanical Engineers, 25, Great George-street, S.W., 11 a.m. 1. Mr. L. M. Kortright, "The Appliances and Operations for Raising the Wreck *Edith*, at Holyhead." 2. Mr. Charles Elwin, "A Floating Dock upon an improved system, at the Victoria Graving Docks." Communicated through Mr. Druitt Halpin. 3. Mr. William Boyd, "Experiments Relative to Steel Boilers." 4. Capt. C. O. Browne, "The Construction of Armour to Resist Shot and Shell." Communicated through Mr. B. C. Browne. 5. Mr. W. S. Hall, "Drilling Machines for Boiler Work." 6. Mr. Francis R. Conder, "The Cost of Working Different Descriptions of Railway Traffic." Communicated through Mr. Charles Douglas Fox.
London Institution, Finsbury-circus, E.C., 7 p.m. Lecture by Mr. E. B. Tylor.
Society for the Encouragement of the Fine Arts, 9, Conduit-street, W., 8 p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Chemistry of the Organic World." (Lecture XII.)
Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.
Royal Historical, 11, Chandos-street, W., 8 p.m. 1. Mr. James Heywood, "Historical Progress of Free Thought." 2. Rev. Prebendary Pearson, "Notice of Churchwardens' Accounts in St. Michael's, Bath, from 1349 to 1575."
Royal Society Club, Willis's Rooms, St. James's, S.W., 6 p.m.
Mathematical, 22, Albemarle-street, W., 8 p.m. 1. Prof. H. J. S. Smith, "Second Notice on the Characteristics of the Modular Curves, and Note Relating to the Theory of the Division of the Circle."

FRI.....Institution of Naval Architects (at the HOUSE OF THE SOCIETY OF ARTS). Morning Meeting, at 12 a.m. 1. Mr. W. John, "The Royal Naval College and the Mercantile Marine." 2. Mr. John Young Short "The Advantage of Greater Breadth in Steamers as Affecting their Speed and Performances and Commercial Success." 3. Mr. John Harvey, "A New Mode of Yacht Construction." 4. Mr. J. St. Clare Byrne, "The Best Mode of Construction of Composite Yachts, Illustrated by the Mode adopted in the *Sunbeam*." 5. Mr. T. R. Oswald, "A New Principle of Construction for Iron Ships." Evening Meeting 7 p.m. 1. Mr. F. P. Purvis, "The Effect of Depth on a Girder to Resist Bending." 2. Mr. T. Adams "A New Safety Valve." 3. Mr. J. C. Spence, "A Definite Ratio of Expansion, giving a Maximum Value for the Mean Pressure on the High-Pressure Piston in any Compound Engine."
Royal College of Physicians, Pall-mall East, S.W., 5 p.m. (Lumleian Lectures.) "Insanity in its Legal Relations." (Lecture III.)
Royal United Service Institution, Whitehall-yard, 3 p.m.
Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Sir Joseph Dalton Hooker, "The Distribution of Plants in North America."
Astronomical, Burlington House, W., 8 p.m.
Institution of Mechanical Engineers, 25, Great George-street, Westminster, S.W., 11 a.m. Reading of Papers and Discussion continued.
Quekett Microscopical Club, University College, W.C., 8 p.m.
Clinical, 53, Berners-street, W., 8½ p.m.
New Shakespeare Society, University College, W.C., 8 p.m. Mr. Frank Marshall, "The Character of Richard III."

SAT.....Institution of Naval Architects (at the HOUSE OF THE SOCIETY OF ARTS). Morning Meeting, at 12 a.m. 1. Mr. W. H. White, "Note on the Geometry of Metacentric Diagrams." 2. Mr. Colin Archer, "The Wave Principle Applied to the Longitudinal Disposition of Immersed Volume." 3. Mr. Samuel Baxter, "The Relative Advantages of Different Designs of Windlass Capstans as Applicable to Merchant Ships." 4. Mr. C. Böhm, "Crude Petroleum Equipments for Purposes of Naval Warfare." 5. Mr. R. Clark, "An Easy and Effective Method of Ascertaining the Rudder Power of Ships."
Physical, The Science Schools, South Kensington, S.W., 3 p.m.
Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.
Royal Institution, Albemarle-street, W., 8 p.m. Mr. Ernst Pauer, "The Clavecinistes and their Works: England and Italy, France and Germany." With Musical Illustrations. (Lecture II.)

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,325. Vol. XXVI.

FRIDAY, APRIL 12, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

The First Lecture of the Third Course, on "Some Researches in Putrefactive Changes, and their Results in relation to the Preservation of Animal Substances," by B. W. Richardson, M.D., F.R.S., was delivered on Monday evening last, the 8th inst. These lectures will be published in the *Journal* during the recess.

INDIAN SECTION.

Friday, March 29th; Andrew Cassels, Member of the Council of India, Vice-President of the Society, in the chair.

The Chairman, in introducing Col. Smith, said that two years ago the great depreciation of silver was the subject of an interesting discussion there. Since then it had lost very little of its importance in India, and although the recent action of the American Government might possibly have steadied, if not enhanced, the value of silver, both the State and individuals still continued to suffer from the low rates of exchange. Under these circumstances, any remedy put forward by a thoughtful, earnest, experienced man, deserved very serious consideration. His friend, Col. Smith, had devoted a great deal of time and thought to this subject, and was in an exceptionally favourable position for dealing with it, having been Master of the Mint in both Madras and Calcutta.

The paper read was—

THE DEPRECIATION OF THE VALUE OF SILVER, WITH ESPECIAL REFERENCE TO THE EXCHANGE BETWEEN INDIA AND ENGLAND; AND SUGGESTIONS FOR A REMEDY.

By Colonel J. T. Smith, R.E., F.R.S.

(Formerly Master of the Mint, Madras and Calcutta).

1. I gladly avail myself of the invitation with which I have been honoured by the Society, to lay before them some remarks on the depreciation of silver with reference to the Indian Exchange, because it affords me an opportunity of submitting for their discussion a measure proposed by me, which has been for some time under the consideration of the Indian authorities, and which has for its object the removal of the difficulties, uncertainty, and losses, which have now for so long a time embarrassed the operations of Indian commerce, and disordered the Indian finances.

2. If it be possible by any means to get rid of the very serious evils just referred to, the subject is, I think, well worthy of the attention of the Society; but the questions involved in any proposal of this kind are generally considered to be of an abstruse and complicated character, and I am painfully conscious of my inability to impart to them any interest beyond that of their own intrinsic importance. Perhaps the most satisfactory way in which to begin the explanation I wish to lay before the Society, will be, first, briefly to state the facts, and endeavour to ascertain the causes of the evils experienced, then to state the remedy which I propose, and, lastly, to offer some few explanations to meet the difficulties which may appear to some minds to militate against the adoption of my proposals.

3. The facts are, unfortunately, only too notorious. We are all aware of the losses which have been experienced in Indian trade, and the embarrassments occasioned to the Indian finances by the fluctuations of the rate of exchange between India and England, coupled with the absolute uncertainty of its course for the future, from day to day.

4. In regard to the former, it is, I believe, a fact that the exports to India were at one time greatly checked, owing to its being found that they produced so much disappointment and loss. On the other hand, it would not be fair to omit that the same causes which produced this discouragement to the import trade into India, increased the profits of the export trade from India; so that there are not wanting those who, confining their attention, perhaps, to one branch of commerce, are inclined to look upon the depreciation of silver as a benefit to that country, though they, at the same time, admit the serious evils occasioned by the fluctuations in the course of exchange.

5. We can easily understand a little bias in the minds of those who, making large unaccustomed profits by the export trade from India, speak favourably of circumstances which created the stimulus and brought them their gains. But the statesman, who looks into the question with a desire for the equal advancement of all branches of commerce, will perceive that what is a stimulus to the one branch is equally a deterrent to the other, the effect being the same precisely as if a bounty were bestowed upon exports, and an equal tax on imports; entailing, it should be observed, the risk, should silver regain its value, of the effect being reversed, and the bounty and tax being applied in the opposite directions.

6. Perhaps it will be sufficient evidence that the accidental depreciation of the metallic contents of the rupee cannot be a real benefit to the country, if I mention that, were it so, the effect of it could be artificially brought about at any time by the Government authorising merchants, for a time, to manufacture the standard coins of the realm with 10 to 20 per cent. deficiency of precious metal, and to circulate them with legal tender as genuine coins.

7. In regard to the disorder of the Indian finances, brought about by the fall in the price of silver, I need hardly remind the Society of the official statement on this subject by the Finance

Minister in his Budget speech of the 31st March, 1876, which contained the following words—"The sudden depreciation of silver and the consequent enhancement of charge to the Government of India of laying down yearly the sum required in England of about fifteen millions sterling, without doubt cast a grave shadow on the future. In truth it may be said that the danger, from whatever point of view considered, is the gravest which has yet threatened the finances of India." Further on he stated "that which adds significance to it is that the end cannot be seen; the future is involved in uncertainty."

8. To this extract it is only necessary to add, that during the last three years the losses actually incurred by the Government of India in the remittances to England, as compared with the rate of 2s. the rupee, have amounted to upwards of five millions of pounds sterling, being an average loss of £1,666,000 per annum, or rather more than £30,000 per week; and similar losses are still being experienced.

9. We have, then, as the facts for consideration a violent disturbance of Indian commerce, stimulating, by the aid of a practical bounty, its exports, which do not require aid, and discouraging its imports which, during the last half century, have been deficient; at the same time inflicting very serious losses upon the finances of the Imperial Government. We have to inquire into the cause of this unwelcome phenomenon.

10. To this end it is needless to adduce any arguments to prove that their prime origin is in the depreciation of the value of silver; but it may be very interesting to exhibit the *modus operandi* of the change, more especially if it should have the effect of bringing to light the other causes without which the sudden fall in the value of the metal would have been comparatively inoperative and harmless.

11. Let us, therefore, consider what the results would have been if India had been a self-contained community, with an internal trade of its present dimensions, but with no considerable foreign relations or commerce. In that case some of the results which have been already observed would have taken place; the currency would have been added to, day by day, by a deluge of coins cheaper than those of which it has hitherto been composed; and, as will be hereafter explained in parapraph 68, these would have continued to swell the currency and diminish its value, until a new point of "saturation" and a new scale of prices had been established. But, if we remember that the constant and rapid increase of the business of India needs an annual addition of five millions sterling to her currency to maintain existing prices, and a still larger importation than that when the ordinary imports of merchandise are checked and diminished; if we also bear in mind the vast amount of the currency, which may be moderately estimated at 180 millions sterling, it is evident that the progress of that change would not be otherwise than slow; like the growth of a child it would be certain, but imperceptible.

12. Let us now enlarge the dimensions of our inquiry, and instead of confining our observations to India alone, include Great Britain in our view, but upon the supposition only that both countries have the same rupee currency, and are governed by the same currency laws as India, and we shall see that the same results would follow. But, as the united currencies of Great Britain and India would be larger than that of India alone, the effect of the stated additions to the joint currency would be less observable; the more so as there would cease to be the stimulus to the export trade above referred to, which is brought about by the lowering of the exchange; the progress would, therefore, be even more protracted.

13. As just implied, there would be no lowering of the exchange between India and Britain, that is, no alteration on account of the decline in the value of silver; because, supposing both countries to possess a rupee currency, the same causes which would operate upon the one would also affect the other; and being in constant commercial communication, the value of their respective currencies, though undergoing a gradual deterioration, would maintain an equlibrium one with the other.

14. Let us now consider what is the consequence of the actually existing state of things, that is, a silver currency in India and a gold currency in Great Britain, together with an open coinage in both countries, including a free permission to any one who pleases to take silver for coinage to the Indian mints. In order to do this, we must bear in mind that the commerce between two countries is the exchange of commodities which are measured against one another by means of the tariffs of prices founded on the currency of either country. In the present case, commodities in England are measured by the average value of gold, in India by the average value of silver. As just explained, these tariffs of price can only be altered gradually, because the cheaper cost of a small part added to the currency only slightly affects the whole, just as a bucket of water added to a lake imperceptibly affects its level. But in regard to the course of exchange, namely, the immediate expense of obtaining a portion of one currency by means of another, it is evident that the cost instantly follows the alteration in the cost of the material on which the former currency is based; for, in fact, the rate of exchange only expresses the cost of procuring one currency in terms of the other. Hence, in this instance, no sooner is there an alteration in the English or gold price of silver, than it indicates and establishes an alteration in the purchase price of the Indian rupee currency, that is, an alteration in the rate of exchange between the two countries; and it is so, because the Indian currency law gives the right to any one having silver to convert it at once into coins. Silver, however much degraded in value below its former price in English money, is permitted, when coined, to take its place in the Indian currency, and command the same purchasing power as the rest of the circulating medium. One hundred rupees, which formerly cost ten sovereigns, can now be obtained at the cost of less than nine, and have the same purchasing power as those previously in circulation, and which are still measuring the value of £10—the essential circumstance which gives rise to this being the open mint and the immediate convertibility of the metal, no matter how much reduced in its value, into standard coins.

15. A metal liable to much fluctuation in price

is not suited to form a standard of value, especially for India, having such vast transactions with countries of a different standard; and silver has become exceedingly liable to fluctuation, in consequence of the events of the last few years. Slight fluctuations, though occasioning loss to individuals, and thus, so far, an obstruction to trade, are of little effect, if there be no decided "set" in either direction; but a heavy fall can only be met by stopping the free use of the mints, and providing for the wants of commerce in some other way, not disturbing the previously established tariff of values. This is the course which has been adopted in France and other States composing the Latin union.

16. Had silver, when it fell to so low a price, been denied admission to the Indian mints, it would have commanded in the Eastern markets only the same value in commodities and gold as it does elsewhere; but the moment it was coined into rupees it was raised to a place in the existing currency, and commanded an exchange for commodities according to the Indian tariff of prices.

17. We must allow, then, that, in addition to the fall in the value of silver, the existence in England of a different standard from that of India, viz., one based on gold, and the free coinage of silver in India, bringing about an immediate and corresponding fall in the exchange with England, were essential elements in the disorders which have been experienced.

18. So long, then, as silver is liable to fluctuate in value, and the Indian mints are open for its free coinage, the Indian coinage being based upon it, and England having a different standard, there must necessarily be fluctuations in the exchange with England, and all the evils attendant upon them.

On the Various Remedies Proposed.

19. The Indian merchants were not long in discovering the evil of a free coinage, when silver was so greatly depreciated in value, and in August, 1876, they petitioned the Government of India to close the mints; but they did not complete their proposal, by pointing out the means by which the wants of commerce, and the expansion and contraction of the currency, were to be provided for. The consequence was that their prayer was refused, chiefly on the ground of its involving, as was supposed, a fall of prices, or in other words a contraction of the currency; although other arguments were used which need not now be dwelt upon.

20. We have seen that the assimilation of the standards of England and India would at once put an end to all the fluctuations of the exchange, with or without the closing of the Indian mints; which latter measure, we may add, might also have been worked so as to produce the same effect; though, for want of proper explanations, it appeared to the Government of India to involve serious inconveniences. The Government, therefore, although implying its preference for the introduction of a gold standard for the Indian currency, and acknowledging the inconveniences and anxieties involved in the existing state of things, stated the opinion that there was nothing in their nature demanding recourse to a measure so "costly," and of which all the requisite conditions were at present so uncertain. The erroneousness of this opinion will be explained hereafter, but in the meantime it is important to observe that, for 17 years previously, the adoption of a gold currency for India had been pressed upon the Government of India, and recommended by almost every financial statesman, upon totally different grounds from those of the present necessity.

21. In the collected correspondence published in Calcutta in 1866, the strongest evidence is afforded of the very eager desire of the European and native merchants and others for the restoration of a gold currency; besides the recorded opinion of every financial minister, beginning with the eminent James Wilson, and including the late Lord Sandhurst and Sir Charles Trevelyan, as to the importance of its introduction.

22. At one time an attempt was made, and, Sir Charles Trevelyan having, in a most able and exhaustive minute, recommended the adoption of the British sovereign as a legal tender for ten rupees, the advice of the late Mr. G. Arbuthnot, of her Majesty's Treasury, was asked, who, in a Memorandum dated the 16th September, 1864, upon the ground that a tentative and experimental course would be the wisest, approved a proposal to receive sovereigns at the rate of ten rupees each, but without making them legal tender. This proposal being carried into effect, the practical effect was that the sovereigns were only paid in when they were worth *less* than 10 rupees; consequently, a considerable accumulation of sovereigns in the Indian Treasuries took place, which, not being legal tender, and, during a high rate of the London exchange, of less value than 10 rupees, became useless. They were therefore transmitted to England, and the experiment considered a failure. This decision, however, was premature, for had the sovereigns been retained till the exchange with England fell, the sovereigns would have been readily sold at a premium. But the attempt to introduce and fix gold in India without stopping the coinage of silver for individuals, would have proved a complete failure, as events turned out.

23. Soon after this, a commission of inquiry was appointed by the Government of India, of which the late Lord Sandhurst was President, and which, after an elaborate investigation, and the accumulation of a very large amount of evidence from all parts of India, made its report in October, 1866, from which the following is an extract:—

> "The Commission cannot hesitate to express a hope that the Government of India will persevere in the policy which was recommended for the approval of the Secretary of State two years ago, viz., to make a legal tender of gold to be a part of the currency arrangements of India."

24. I have already remarked that the proposition of the Bengal Chamber of Commerce in August, 1876, was not sufficiently explained to the Government of India, or it would have been seen that the evil consequence apprehended from it might have been easily prevented.

25. It is a most remarkable circumstance, that throughout the whole of the discussion of this important subject, by statesmen of the very highest ability, and merchants thoroughly acquainted with all the commercial features of the case, no reference was made to the peculiar relations to it of the Council bills and the exchange, as pointing out and leading the way to a solution of many of the diffi-

culties. It is true that, in the discussions of the Bengal Chamber of Commerce, the strengthening of the exchange was mentioned as a probable result of closing the mints to individuals, which shows clearly that the facts of the exchange were not overlooked by them; but it might have been pointed out, in answer to the objection made by the Government of India to their proposal to close the mints, that by the issue of Council bills on the requisition of merchants needing them, whether or not in excess of the home requirements, and by the transmission of silver to the mints for coinage on account of the Government, the expansion and contraction of the currency would go on automatically, just as at present; and the objections of the Government to the measure on that score be wholly removed.

26. Before submitting to the Society the remedial measures I propose, I will just glance very briefly at those which were suggested on the last occasion, when the subject was discussed in this Section about two years ago.

27. In the very elaborate and able paper read to the Society by Mr. Ernest Seyd, it was proposed that the double valuation of both gold and silver should be introduced into India, all other nations coming to an international agreement on the matter, for which purpose a conference was to be held, and treaties of agreement entered into. This proposal has been very ably advocated, besides Mr. Seyd, by MM. Wolowski, Cernuschi, and others; but it is not necessary to refer to their reasoning in order to justify the recommendation of another plan. Admitting, for the sake of argument, that all the advantages contended for would surely follow the adoption of the proposed measures, by general agreement, it is enough to say that it is absolutely hopeless to expect that such a general agreement is attainable, within this generation, or indeed most probably at any other time.

To go no farther than the first step in the arrangement, it appears to be certain that neither Great Britain nor Germany would ever consent to the change.

28. General Marriott, in commenting upon Mr. Seyd's paper, expressed his wish for the double standard in India, though he considered it would be useless to attempt its introduction when silver was depreciated in value, because the cheaper silver would most effectually keep out the gold. Had the thought struck him of introducing the gold and stopping the coinage of silver, he would no doubt have perceived how very easily the change would have been effected thereby.

29. Mr. Frederick Hendriks, after a masterly analysis of Mr. Seyd's somewhat alarming statements, submitted to the Society a very carefully prepared plan for the coinage reform of India, by the establishment of a temporary transition double standard of gold and silver, and the ultimate adoption of a 10 rupee gold piece of a value one eleventh less than our British sovereign, with new silver rupees of rather more than 11 per cent. less metallic value than the present ones. This scheme would involve the recoinage of the whole of the present Indian rupees, which were estimated by Colonel Hyde, late Master of the Calcutta Mint, in his evidence before the Silver Commission, at 166 millions sterling value in 1868, or 1,660 millions of pieces; an operation which added to the unavoidable coining on account of trade, would be a very serious and burthensome task; though it would not be an insuperable obstacle, if there were not other and greater difficulties. One of these is the fact that the new rupee could not be coined on behalf of the public, because as the silver contained in 10 rupees could (at 54d. per oz.) be procured for 178½d., and the gold for the new 10 rupee piece would cost nearly 218d., if the public were allowed to bring silver to the mints, not an ounce of gold would be brought for coinage, and the whole scheme would fail. The new rupee could therefore only be obtained by re-coining the existing currency or new silver by the Government; which, indeed, would be a profitable operation, provided only the coins could be put into circulation together with the present coins, but this I should fear would be quite impossible.

30. It could not, indeed, be expected that the new rupees of 11 per cent. less metallic worth would be accepted by the natives as of equal value with the old ones. Their true value containing 146·77684 grains pure,* would be only 14 annas $2\frac{3}{4}$ pies, instead of 16 annas, and it would be in vain for the Government to attempt to introduce them at the higher value, even if it would be considered honest to do so.

If the new coins, instead of being substituted for and circulating concurrently with the old, were introduced at the lower value, there would be a revolution of the scale of prices, and the re-coinage of the rupees would involve an expense of 1 to 1½ millions sterling.

31. Another difficulty would be that, in consequence of the introduction of a 10-rupee gold piece containing only 102·7287 grains of pure gold worth 217·831538d. at 933d. per standard ounce, without seignorage, the exchange with England would be immoveably fixed at rather less than 1·10d. the rupee, involving a permanent annual loss in remittance of £1,250,000, or more than £24,000 per week, to the Indian Government; besides two or three millions per annum more in her expenditure, owing to rise of prices. Hence it will be seen that, involving as it does the re-coinage of 1,660 millions of pieces, a total revolution of the scale of prices, and very heavy annual losses to the Indian Treasury, the measures proposed by Mr. Hendriks would not be desirable unless there were no other easier means of accomplishing the end proposed.

The True Remedy.

32. The above are the suggestions which survived the discussion of this important subject two years ago; and their investigation affords a clue to the difficulties which have beset the problem on every occasion when its solution has been seriously attempted. The chief difficulty seems to have been the existence of a large mass of standard silver coins which it was impossible to convert all at once into "tokens," and therefore the apparently inevitable necessity for the concurrent circulation of standard coins of the two metals; a fact which induced many of the statesmen who had to deal with the question to consent to a "double standard," at all events for a limited time.

33. I have before pointed out how the difficulty just stated might have been very easily overcome;

* Worth 17·8512d. at 54d. per oz. standard.

but it is not at all necessary now to enlarge upon it, because I have the gratifying privilege of being able to state that, owing to recent events, the difficulty has altogether vanished, and that the extraordinary and fortuitous position of the Indian currency is such as to put the desired change within our reach without the slightest difficulty or risk of any kind. Let me illustrate this by a somewhat extravagant, but I trust not inappropriate, imagination.

34. Let us suppose that India and its currency being what they were, say five years ago, with the wants of trade provided for by a circulating medium of 1,660 millions of rupees, which had established a scale of prices throughout the empire indicating their value as two shillings each, that it was very earnestly desired to introduce a currency of gold coins, to take the lead in due time and regulate prices; and to do this without making any disturbance, by quietly and gradually slipping into the, at present co-equal, but hereafter dominant position, with a true token currency of equal local worth. Let us suppose, also, that the Finance Minister of the empire had the assistance of a magician or fairy, who told him that the whole could be accomplished by a single miracle, which, if he would reason it out and ask it of her, she would, by a stroke of her wand, accomplish for him; what, let us consider, would be his choice, and the answer he would give?

35. As the result of his careful study, inquiries, and investigation, our Finance Minister would at last arrive at the conclusion that an enormous mass of currency, such as that of the empire, although formed of a multitude of successive values added together to constitute its bulk, and representing the average of the whole of them, could not be materially affected by any difference in the value of each fresh comparatively small portion added to the mass; and he would discover, also, that commodities (which, indeed, and not money, constitute trade), are compared with one another by a scale of prices which varies very slowly in accordance with the average value of the whole mass of coins, not at all by the varying value of the particular individual pieces which constitute the mass, except in so far as they, in time, affect the general average. He might, therefore, argue thus with himself. In so far as securing the undisturbed continuance of the present prices is concerned, I can certainly effect that by not allowing any cheap silver coins to be introduced, that is, by closing the mints to silver, and then no change in the average can possibly take place; for, as it happens that the wants of trade necessitate constant additions to the currency, I can allow these additions to be made by gold coins *precisely* adapted to the value of that general average. I shall then, as additions to the currency are steadily required at the rate of 5 millions sterling per annum, in a few years have 30 or 40 millions of leading gold coins circulating concurrently with rupees, and most probably that will be all that is required; if not, a few more year s will certainly accomplish it, and so I do not need any help at all, and I shall decline the offer of my benevolent fairy.

36. Stop, says the latter, you have not described the accomplishment of your object. You have contrived an arrangement which will only partially effect your intention, an arrangement not indeed a double standard, but in one particular subject to its evils. By introducing gold at the precise value of the present silver coins you will, it is true, avoid any disturbance of prices; and by admitting only gold from the public in future, that metal will hereafter regulate prices and become the standard. Still, you do not seem to have observed that, as your gold and silver coins are precisely equal in value at present, you are not quite safe from one of the evils of a double standard. The silver coins cannot drive out the gold, to be sure, for you will not give them admission to do so; but how about the gold driving out the silver? You cannot limit or obstruct the free entrance and exit of gold into and from your currency, that being your standard, for if you do the currency will not be automatic, and expand and contract in strict and immediate sympathy with trade. How, then, will you secure your silver coins from being chased out of the empire, if you make the gold coins at first of precisely equal value, and hereafter they should happen to become cheaper?

37. I admit the truth of your objection, would be the reply, and I see now what is wanting; what, I would ask you, therefore, to do for me is that when I close the door to the admission of silver to the currency, and employ gold for further additions to it, you would, by your magic power, discredit silver in the other markets of the world. That will cause it to fall in value, and then, to whatever extent you do that, my silver currency will be quite safe from being driven away, unless and until gold shall also have lost credit in the markets of the world to an equal extent. In fact, then the silver rupees in my currency, circulating, as they will do, at a higher value (that is, their present value) than that of the metal they contain, will be true "tokens," like those of Great Britain, and our Indian currency will be assimilated to that of the mother country.

38. The request is granted, and the benevolent fairy not only reduces the value of silver in the markets of the world to an extent sufficient to keep the rupees secure in the Indian currency, but adds another favour, by pointing out a private door of admission to the circulating medium by means of Council bills. The minister is warned to take care to sell these at the former average value of the rupees, and to take care also not to waste much time in carrying out his arrangements, lest the successive additions of fresh masses of cheap rupees should have the effect of lowering the average value, and increasing the present scale of prices.

39. This fanciful sketch illustrates the present position of affairs, and it is intended to show the extraordinary and propitious accident which now offers the opportunity of effecting a change which has been for so many years desired, without the smallest difficulty, inconvenience, or risk of any kind. The important peculiarity is that the rupees are now circulating at a local value superior to their metallic worth*; and, if care be taken to prevent their numbers being unduly increased, they may be fixed at that value, and, being con-

* The rupees are now circulating at more than 12 per cent. above heir metallic worth, and if the rate of exchange were 2s. the rupee, the price of silver must rise to more than 65d. per ounce before it would pay to send them to England as a bullion remittance.

current with gold pieces of metallic as well as local worth, they will be clearly understood to be what they now are, namely "tokens."

40. My proposal, to which I have referred at the beginning of these remarks, was the following:—"That, after due notice, the coinage of silver on behalf of private individuals and advances upon silver bullion should be suspended, that part of Act 23 of 1870, which makes it incumbent on the Government to receive and coin it, being repealed, the Government retaining in their own hands the power of replenishing the silver currency whenever they may deem it expedient. That gold bullion should be received by the Government at the mint rate of Rs. 38 14 As. per standard ounce, and coined into sovereigns and half-sovereigns (representing Rs. 38 As. 15), or ten and five-rupee pieces of the same value, which should be declared legal tender, but not demandable,* the present silver rupees continuing to be legal tender, as before.

41. "No seignorage should be charged for the manufacture of the gold coins beyond that implied in the terms of purchase, which are the same as those of the Bank of England, and yield a profit of one anna per ounce, or one-sixth per cent., which is more than enough to pay all the actual outlay."†

42. The foregoing scheme would have the effect of merely transferring the standard of value from silver to gold, without in the least altering the value itself, owing to the extraordinary and fortunate accidents of the present situation of the Indian currency.

43. It will be shown hereafter,‡ with reference to the important object of introducing the change without disturbance of the existing distribution of the precious metals throughout the world, that a gold currency is not essential to the existence of a gold standard; and, paradoxical as it may appear, that it will be quite easy to establish a dominant gold currency in India without making the smallest further demand than the present upon the produce of the mines; and at the same time, although the mints are closed to silver, to keep up the silver coinage at the gold value, and to meet and fulfil the expansions and contractions of the currency, through the agency which will now be described.

44. The following is the *modus operandi*:—When the coinage of silver is suspended, the rate of exchange will rise, because the remittances to be made to India have always been greatly in excess of the Council drafts, as shown by the shipments of silver bullion, to the amount of five millions sterling per annum; and on the suspension taking place, the rate would rise to two shillings the rupee; or more if desired, as silver, even if cheap, would be useless.

45. The cause of the rise in the rate of exchange here mentioned will be readily understood if we remember that, while the remittances to be made to India amount to 20 millions per annum, the Council bills only dispose of 15 millions. The difference is met by sending out silver bullion to India for coinage. When the use of the mints by individuals is put a stop to, there will ensue a famine of remittance, which would cause a competition for the Council bills, more or less active, according to the sufficiency or otherwise of the amount of Council bills offered for sale to meet the demand. If the Secretary of State, after the mints were closed, should offer bills to the extent only of the home expenses, there would be a serious deficiency of the means of remittance, which, at the end of three months, would be represented by a million and a quarter sterling. If he offered bills for sale in excess of the home requirements by fully $1\frac{1}{4}$ millions, there would be comparatively slight competition, and the rate of exchange would rise but slowly. Hence the rate might be gradually raised, either by slightly restricting the supply, as just explained, or by giving some such a notice as the following:—That after six months the present minimum rate for Council bills of, say, 1s. 9d. the rupee, would be raised to 1s. $9\frac{1}{4}$d., and that it would continue to be raised by $\frac{1}{4}$d. every six weeks till it reached 2s. the rupee, when it would remain unaltered. The Secretary of State undertaking to grant bills and telegraphic transfers at the rates so fixed to all parties requiring them.

46. When the rate has risen by competition or otherwise, to two shillings the rupee, the Secretary of State would undertake to sell bills for the future *to all comers*, at that rate; and then nothing more would be required, except that he should send out to India silver purchased with the money received in excess of the requirements of the Home Treasury. The change of standard would then be accomplished, and there would be an absolute end to all the uncertainty and losses hitherto experienced.

47. When the coinage of rupees for individuals is suspended, and the currency is procurable only by gold or bills, it will rest with the Government of India to fix the rate at which bills shall be drawn; and if the Secretary of State issues bills at 2s. the rupee, or a lower rate to all applicants, the effect upon trade and the currency will be precisely the same as if, nothing having been done, that same rate of exchange had been arrived at in consequence of other circumstances, and had become permanent. The rate fixed being 2s. the rupee, or less, it would not pay to send gold; and thus exactly the same amount of silver bullion would be sent out to India and added to the currency as would be the case under existing circumstances at the same rate; the only difference would be that it would be sent by the Secretary of State instead of by the merchants (who would take bills instead), and would be coined by the Government of India. The quantity so sent out would be regulated strictly as at present, by the balance of trade, and the amount of funds requisite for the Indian home expenses.

48. If the Secretary of State were to fix the rate of exchange at 1s. $11\frac{7}{8}$d. or less, no gold would be taken to the Indian mints for currency purposes, although the standard were changed, and the mints freely open to receive it.* Trade and com-

* As the expression "not demandable" has given rise to objection, it may be pointed out that it is not at all essential. So long as rupees are legal tender, no debtor can be compelled to pay in gold.

† This statement is founded on the fact that the cost of coining rupee pieces in the Calcutta Mint is from $\frac{1}{2}$ to $\frac{3}{4}$ per cent., or eight to twelve annas per hundred pieces. One-sixth per cent. on gold n-rupee coins would be one-sixth of ten rupees, or $26\frac{2}{3}$ annas.

‡ Vide paras. 70, 72 and 82; note. para. 119, and paras. 94 to 106.

* Although no gold would be brought to the mints for ordinary currency use, there might, nevertheless, be a considerable quantity

merce would be carried on precisely in the same way as at present, with the very great and important advantage of a permanently fixed and reliable rate of exchange.

COUNCIL BILLS AND THE EXCHANGE.

49. Before proceeding to inquire into the difficulties and objections which to some minds have appeared to stand in the way of the proposed plan, it may be useful to say a few words more on the subject of the Secretary of State's, or as they are more frequently called, the "Council bills" on India, and their influence on the currency and exchange.

50. These bills represent that part of the produce of the Indian Empire acquired by the Government in the shape of taxes, which, like the income of an absentee landlord, is sent to England to meet the home expenses. If the Government of India were to buy the produce in the markets there, and send it home to be sold on account of the Secretary of State, there would be no need of Council bills, and no interference with the exchange; but there would be an interference with the markets, and that might at times be equally, if not much more, objectionable.

51. The Council and private bills were together estimated in Parliament at 20 millions sterling annually, and they offer the means of procuring rupees without delivering silver, which is the standard of their value, but, instead of it, pounds shillings, and pence, that is, virtually, by the delivery of gold. One is almost tempted to say that India suffers from a double standard, because it is true that the currency can be obtained by the delivery of either silver or gold; and such would be the case if bills could be freely claimed as a right, to an indefinite extent, at a fixed rate of exchange; for then the Indian currency would be obtainable by the alternative surrender of given quantities of either silver or gold, and the two would compete against one another.

52. But it is not so; and the double standard does not exist; because, owing to the circumstances of the case, it is absolutely indispensable that a large part of the surplus exports must every year be paid for by the gold-bought rupees, and the Secretary of State is therefore compelled to modify and reduce the price of his bills, that is the quantity of gold asked for the rupee, so as to keep the bills at all times cheaper than the silver price; the result of which is that silver remains the regulator of value.

53. But, supposing the alternative of the silver delivered for the rupee were altogether withdrawn, and that the Council bills engrossed and paid for the whole of the surplus exports from India, and that the Indian currency were procurable *only* by Council bills—that is, virtually, by the delivery of gold—then it is evident that the value of the rupees brought into the currency would depend upon the number of ounces of gold, or the price in pounds, shillings, and pence, paid for a number of them, that is, upon the rate of exchange; and, in like manner, when the coinage of silver is stopped, whatever may be the rate of exchange, gold, and gold only, becomes the regulator of the value of the Indian currency, for the time being.

54. For instance, if the coinage of silver were stopped, and the rate at which the Council bills were sold was 1s. 8d. the rupee (and this rate could not be changed except by the option of the Secretary of State, there being no other way of obtaining the currency), the effect would be the same as establishing the standard of 10·273 grains of gold for the rupee; and this would continue indefinitely, the standard being changed from 180 grains of standard silver to 10·273 grains of standard gold.

55. In these circumstances, the Council bills would constitute and bring into operation a new standard of valuation of the Indian currency, there being no other; and this value of new standard would depend upon and be fixed by the rate of exchange. It remains, therefore, only to inquire what that rate ought to be, in order to interfere as little as possible with the former normal scale of prices, and restore matters to what they were previous to the commencement of the present disorder. This will be investigated more fully hereafter.* In the mean time, I may here say that there can be no doubt that the proper rate is 2s. the rupee.

56. It is important further to notice the relation between the Council bills and the price of gold in India. It may be observed that when in Calcutta a demand bill on London produces one rupee for each 1s. 8d., a sovereign, which is of equal or more value to a traveller, would be worth 12 rupees. If, on another occasion, the demand bill were at such a rate as to give 2s. 6d. for each rupee, a sovereign would be only worth 8 rupees. In like manner the price of gold bullion which, subject to the charges of transmission, represents English money, varies in the Indian market with the price of English money in the shape of bills.

DIFFICULTIES AND OBJECTIONS.

57. The main proposals above described were submitted for approval two years ago, and since then I have taken great pains to discover every objection which can be fairly brought against them; but none have been adduced which appear to be of real importance. It is true that innumerable doubts have been suggested upon a variety of topics connected with them, but they are in most cases the misgivings of persons imperfectly acquainted with the principles of monetary science, or of the peculiarities of the Indian currency and exchange.

58. In regard to a number of these objections, full explanations and answers were printed in three essays, which were submitted to the Secretary of State in Council, and were afterwards published by Mr. Effingham Wilson, of the Royal Exchange, under the title of "Silver, and the Indian Exchanges." The object of the publication was to elicit, as far as possible, any further objections; to which, and especially to four by the late editor of the *Economist*, answers were printed in a fourth and a fifth essay, and submitted to the Secretary of State. These were not published; but

brought for coinage on other grounds. India imports more than four millions sterling of gold annually for hoarding and ornaments, and it is not unlikely that part of this and of the immense hoard already in India would be brought to the mint, the charge being so low as one-sixth per cent. plus refinage. Gold might also be coined at first for sale in the bazaars, if the coins commanded a sufficient "*agio*."

* Vide §§ 107 to 110.

they may be procured by any gentleman possessing the published essays, and anxious to peruse them. On the present occasion, as it would be almost an endless task to endeavour to remove all the doubts which may possibly be suggested, I shall confine myself to a notice of those only which are likely to occur to gentlemen not unacquainted with economic science, of which a brief explanation will be given, whether they have been answered before or not.

59. The first explanation will have reference to the doubt as to the expediency of allowing rupees to circulate at what is called an "artificial value;" to which precedence will be given, not merely because it is a deeply-rooted feeling entertained by many persons otherwise well-informed, but because the investigation of principles necessary for its elucidation will be of great use in the consideration of other points requiring attention. It will be shown that the value of the rupees in the home markets will continue to be as unquestioned and real as it now is, and always has been; and, in fact, that the measures proposed are the only means of preventing their value from becoming degraded.

2ndly. It will be proved that there is no breach of faith or injustice in the proposed measures; but that, on the contrary, the only injustice consists in allowing the continuance of the present state of things.

3rdly. The explanation will be afforded that, although a curreney of gold coins is by no means an indispensable accompaniment of a gold standard, yet that by the proposed measures India may be supplied in that respect to a sufficient extent, to the great advantage both of her internal and foreign trade, without producing the slightest alteration in the distribution of the precious metals throughout the world.

4thly. The reasons will be stated necessitating the adjustment of the rate of exchange to two shillings per rupee.

5thly. A few remarks will be made respecting the dangers of forgery and unlawful coinage.

60. Beyond these explanations no more will be attempted, except a few brief remarks as to the supposed vast expense of a change of standard, the confusion attending it, and the losses which it might occasion to individuals.

On Artificial Value, and the True Basis of Value in a Currency.

61, This important objection springs from a theory of the value of money, and its use in exchange, which will be seen to require some modification when closely investigated. The theory has been stated as follows:—"The metal of every legal currency does its work as a commodity, by means of its value in the metal market. A sale for metallic money is an exchange by pure barter of two commodities of supposed equal value. It is absolutely impossible to give any intelligible and conceivable explanation of metallic currency, except upon the perception of this nature of the action of money."

62. What is wanting here is the rationale of the process by which the two commodities are "supposed" to be equal in value. In other words, an explanation of the way in which gold acts as a measure of the value of other commodities.

63. Here it is necessary to point out that, when we speak of gold as the standard of value in England, and silver of that in India, these statements, though generally correct in the sense understood, are not more scientifically correct than would be the assertion that the pendulum is the standard of length in England; which it is in the same sense and degree. It would be more precise to say that it is not gold, but the *value* of gold, which is the measure of other values.

64. We are all aware that the Legislature has specified a certain exact quantity of gold which is established as the unit of our monetary system, namely, the pound sterling, represented by the sovereign, containing 123,274 grains of standard fineness; but, then, the question arises, How is the comparison brought about between these coins and commodities of all kinds? How is the price of each article fixed according to the scale of our currency? Or, in other words, how is the market value of our currency adjusted to the value of all other articles?

65. The answer to this is, that there is a constant struggle between the buyers and sellers of commodities, the one to buy as cheap, and the other to sell as dear as he can;* and that the value, and consequently the price of any article, depends upon the proportion of the supply of it to the effective demand.

66. With all freely produced commodities for which there is an effective demand, the competition of sellers, by constantly increasing the supply, lowers the price to the cost of production plus a fair profit. And the value of the instruments of exchange, or "circulating medium," is fixed in like manner. There is a constant and universal demand for them, and a continuous supply; but it is a supply leading to accumulation; consequently, the bulk of the currency is always on the increase, until, "*cæteris paribus*," its proportion to the demand becomes so large, and its value, compared with commodities, so small, that it fails to afford the necessary moderate profit; and it accordingly ceases to be supplied; the gold on which it is based being carried elsewhere.

67. I insert the words "*cæteris paribus*" in order to intercept the objection that it is not merely the bulk of the currency which affects prices, but also many other things, which is quite true; but, although the latter may modify the action, they do not invalidate the principles referred to.

68. One main principle is, that when the cost of procuring the circulating medium of a nation is so great as to leave little or no profit to the parties who would otherwise supply it, the currency may be said to be, for the time, "saturated," and, apart from disturbing causes, prices would be steady at the rates established.

69. In like manner, when the precious metals are poured into all the markets of the world, they accumulate till the rise of prices forbids their further production. In regard to particular countries, the stream of supply from the mines ceases as soon as prices in general have risen so high that the capital and labour necessary to produce the precious metal to pay for the currency, and by means of it for commodities, is equal to that re-

* Macleod's "Principles of Economical Philosophy," vol. i., p. 647.

quired to procure the commodies themselves, or to pay for them elsewhere. In Great Britain, for example, the value of our currency in exchange for commodities depends upon, and is regulated by, the expense of procuring the gold necessary to obtain the sovereign. It is a self-acting operation, automatically regulating prices, or, in other words, the value of the currency.

70. It is important to notice, that it is not in reality essential to the local value that the gold should be put into the sovereigns. They would be worth the same, and settle down with the same tariff of prices, so long as it required the sacrifice of the same quantity of gold to procure the pound sterling, whether the sovereigns contained it or not. If the coins were merely inimitable, tokens made of somewhat inferior metal, provided they could not be procured *by any possibility* at a cheaper rate than by the sacrifice of the full quantity of gold, they would accumulate to the same point of "saturation,"* establish the same prices, and be of the same value in exchange, *within this country where they are legal tender*, as the true sovereigns.

71. I must here mention that throughout this paper I endeavour to avoid repetition by not adverting at all, except in answer to an objection on that ground, to the risks of forgery and fraudulent coinage.† They are, to a certain extent, serious, and deserving of attention; but the difficulty is one of practical administration, not of theoretical discussion; and it would cause a perpetual interruption to be obliged to notice them in every case.

72. The point which I am anxious to insist upon *now* is, that a legal tender currency, entering into the home market with commodities, has the same basis of local value in exchange that the commodities have, namely, the cost of production, irrespective of the value of the materials of which it may be composed, of which value, indeed, the public know little or nothing; and this a value quite as real as that of any commodity; the currency being assumed to have arrived at the point of "saturation" as above explained; the instruments of exchange being supplied at a minimum of profit, and commodities at such prices as they command, subject to competition. Stated in other words, the proposition is, that a legal tender currency has a value in exchange which is not necessarily identical with the value of the materials of which it is composed, but which is based on the necessity, in the present day, for the use of money, and the amount of sacrifice unavoidable to procure it.

73. In the above remarks I except the case of a redundancy of the circulating medium, to which every kind of currency is liable; and which, in an old-established country like England, subject to the vicissitudes of an extensive commerce, might undoubtedly take place, were it not protected by the self-acting remedy instantly brought into play when part of the currency consists of full valued gold coins, by their being melted and sent abroad. Such a congestion of the currency, however, could not take place in India for the next half century, for her currency never ceases to require constant and large additions; and the rapid development of her commerce, by the measures now being taken to extend and open up her communications, cannot fail to cause its prodigious expansion, and further increased demands for circulating medium, as time rolls on.

74. When the currency is based on gold, and there are no gold coins, the remedy for congestion is that pointed out by the late Mr. Ricardo, namely, the purchase and export of gold bullion. But, as I have shown in another part of this paper,* if a gold standard were adopted for India, and the mints open for its coinage, there could not fail to be an abundance of gold coins for such a purpose, besides an enormous stock of gold bullion; should it by any possibility be required, under any circumstances.

75. When persons speak of "artificial value," they confound the value of the currency with the value of the material of which it is composed; and when they scout the very idea of using "token" coins as the currency of a country, they have in their minds the well known dangers of depreciation of notes issued *ad libitum*, or without a proper fixed limit; and forget the essential difference of a currency based on gold, and issued only and exclusively in exchange for it.

76. From the foregoing it will be perceived that the value of a currency in the home market is regulated, like that of all other articles, by the demand and supply; and that it is limited and fixed by the cost of production of the commodity given for the currency, whether the latter perform its functions, and circulate from hand in the shape of full-weight coins, or of more or less weighty tokens. Even full-weight coins, within the limits of the country where they circulate as legal tender, do not do so altogether as commodities, but more as tokens representing values according to the tariff of prices, whatever their own individual worth may be outside their legal sphere. Rupees in India have always circulated at a value $2\frac{1}{2}$ per cent., and are now (January, 1878) at 12 per cent. above their metallic worth; and the same is true, to a small extent, even in regard to sovereigns in England, which circulate somewhat above their reputed, and still more above their metallic worth.

77. To return to the method of comparing the value of the currency with goods, we may say that, although it is quite true that in making a purchase for money we virtually barter gold or a legal claim to gold for the article bought; and in uncivilised countries the actual and bodily transfer of the precious metal is the whole history and *rationale* of the transaction; yet in England, at the present time, it is hardly correct to say that when a man engages to pay so many pounds sterling he "barters" so much gold, as a commodity, against goods. There is not one man in a hundred who knows how many grains of gold constitute a pound sterling, or what the cost is per ounce, or what the value of the ounce is, as compared with commodities. From my point of view, it seems to be absurd to say that a young lady purchasing a dress "barters" the gold contained in her sovereigns against the articles she buys, when neither she nor the shopkeeper has the least knowledge of the value of gold, or of the sovereign, except as being the "pound sterling" of the currency, whose relation

* *Vide* § 68 supra.

† See §§ 111 and 112; also Essay V. *Vide* § 58.

* *Vide* §§ 94 to 103.

to the tariff of prices they are both familiar with.

78. It may, indeed, perhaps be said that, in England, at all events, most people do know the value of gold, and that it has a precise value of £3 17s. 9d. per standard ounce. This, however, is a mistake—£3 17s. 9d. is not the *value*, but the price of gold. It, in fact, indicates not the value of gold, but the value of our currency, and shows that 933 pence of the currency are of the same value as one ounce of standard gold, *whatever that may be.*

79. It may, perhaps be said all this is very true; and, confining ourselves strictly withiu the limits to which the legal tender applies, it may indeed be the fact that even a system of counters would be of the same use as coins of metallic value; but the question is, what, then, becomes of the external trade? And how is it possible to expect that foreigners will give their goods in exchange for tokens of no use whatever to them?

80. This objection would be completely met if the tokens were by law exchangeable at the mint for gold bullion at par, for export; but, independently of this, the answer is, that even mere tokens, if founded on a specific basis of gold, and *not redundant*, are as valuable, locally, as notes payable on demand, based on the same gold. This may no doubt be hotly disputed, but if the conditions of the case be fully considered, it will be seen to be correct. The hypothesis is that the tokens are procurable in no other way except by the surrender of the full value of gold, and it is evident they will be supplied only so long as it pays to do so. In other words, the tokens will be supplied only so long as they will purchase in the market the full equivalent of the cost paid for them, in all articles, including gold bullion; and there is no subsequent redundancy. Consequently, the price of gold must be the same as that paid for the tokens, and they may at any time be exchanged for gold bullion at par. This remark would apply even to paper notes issued on deposit of gold; and, *a fortiori*, to rupees issued only for full value of gold, and, besides that, containing nine-tenths of that value in silver.*

81. The above remarks are intended to meet the objection which might be raised against using "tokens" as the sole currency of a country, without any assistance from a dominant gold coinage; but as I have just stated, and shall presently show more fully,† there would certainly be no want of a sufficient gold currency in India, under my plan; and that without the slightest disturbance of the present and future distribution of the precious metals throughout the world.

On Breach of Faith, and Alleged Injustice to the Natives of India.

82. In the former part of this paper the endeavour is made to establish the principle that the currency of a country does not measure values in the way generally supposed, namely, by comparison of the actual intrinsic worth of the individual current instruments of exchange, if they are "legal tender," but in a different way altogether, namely, by the abundance or scarcity of them, in comparison with the demand, the supply being limited by the cost of their production, and the value of the currency being shown by the scale of prices, which it insensibly establishes. Hence, the circulating medium might be preserved at an uniform value, depending upon the cost necessary to procure it, as indicated by the slale of prices, although the individual pieces were in reality more or less defective in metallic value; and if the cost of procuring the currency were maintained uniform, the value of the currency and the scale of prices would be uniform also; consequently the mere material of which the currency is formed is, comparatively, of no importance, and there could be no breach of faith in changing it. It may be stated, too, that a large part of the Indian currency is at present annually procured by the delivery of gold, in the purchase of bills, and a much smaller part by the delivery of silver. The proportions are varied according to circumstances, but, as the purchases made of the currency are at the same cost, whether by silver or gold, it is obviously immaterial to the public which mode of admission is made use of. Besides which, if there be any breach of faith in the matter, it might have been asserted long ago. The truth is, that if the cost of procuring the rupees be kept strictly unchanged, no injury or breach of faith could be perpetrated, but, on the contrary, great benefit gained by the mercantile community; the payment for them being made always by one metal at a fixed rate, instead of by two metals alternately, at varying rates.

83. On this subject the late Lord Sandhurst, then Sir W. Mansfield, wrote in his minute of the 8th March, 1864:—"If on the contrary, the convenience of the community be increased by a change in the currency machinery, as caused by a superior portability and economy, it is indeed idle to maintain that there is even a semblance of breach of faith with the public creditor." The following remark was also made by the late Mr. G. Arbuthnot, of her Majesty's Treasury, who was consulted upon the question:—"And it would be a pedantic subserviency to regulation to maintain that a debt contracted for a payment in silver should never be discharged by its equivalent at any given period in gold." Dr. Nassau Lees, also, in his "Drain of Silver to the East," writes as follows:—"It would be absurd and ridiculous to lay it down as a maxim, that Governments who considered it wise to maintain a single standard could not, however beneficial it might be to the country and the people, change that standard without being accused of an intention to defraud their creditors and to break faith with the public."

84. I will now proceed to consider the question

* The principle above contended for is not unimportant, for it follows from it that, were it not for the sentimental prejudice which prevents the use in England of bank notes inconvertible except into bullion for export, and if the nation could be pursuaded to forego the use of a gold currency for sixty or seventy years, the capital released by that sacrifice, after setting aside an ample reserve of bullion for export, would redeem a very considerable part of our National Debt, without a farthing's expense to any one, or the least disturbance of the home tariff of prices and the foreign exchanges It is worthy of consideration whether the removal of such a burthen rom the springs of our industry would not be of considerable importance hereafter in the life and death struggle in which we shall ompete with the manufactures of foreign nations. The same principle also leads to a solution of the "Double Standard" problem; because it shows that a silver currency purchased only by gold, may be of identical value in the local market with a gold currency. —*Vide* note § 119.

† Vide § 94 to 106.

as to the injustice done to the natives of India, by the rectification of the currency, and preserving to rupees, as tokens, a value in exchange superior to their metallic value in the markets of the world. Gentlemen who make this objection sometimes say that the Government of India have solemnly declared, by legislative enactment, that the Indian rupee shall consist of 165 grains of pure silver and 15 grains of alloy, and that to change the standard, and declare that the rupee shall consist of any given quantity of gold, is to inflict a hardship and grievance not to be spoken of. The mistake here lies in the supposition that to change the standard from silver to gold would require that all payments should henceforth be made in gold. But this is not the case; all that is necessary is that the payments should be made in a currency regulated in value by gold. It is forgotten that, according to my proposal, the rupee will still be constituted precisely as at present according to law; that there will not be the slightest change in it, and that a creditor who claims a debt of 1,000 rupees, will receive precisely as many grains of silver as he would under existing arrangements; and these too of their full present value, in exchange for commodities, instead of depreciated rupees, which he will be compelled to take if the proposed plans be not adopted.

85. But, it is urged, a man has made a contract to pay, and another to receive so many grains of silver. Both have equally agreed to take their chance of a rise or fall in the value of the metal, and now that it has very decidedly changed in favour of one of them, you (the Government) step in to prevent his gaining the advantage, and thereby do him a great injury and injustice.

86. This complaint is founded on a misconception which it is very important to clear up. When it is said a man makes a bargain, in rupees, to receive so many times 165 grains of pure silver, the statement appears to me to be a mistake as to fact. There is not one man in a hundred who knows when he makes a contract in rupees, how many grains of silver he has to receive for each rupee. If it be true, as I venture to assert, that in ninety-nine cases out of a hundred, parties entering into contracts expressed in rupees, do so, estimating them *not* by their weight and value as metal, but as factors in the scale of prices, and trusting that they will continue to hold the same place in that scale at the end as at the beginning of their contract, then I would ask whether, as a mere matter of justice, it is proper that the Government, the only power competent and capable of preventing the wrong, should stand by and allow one party to make a profit he has not earned, and the other to incur a loss he has not deserved, to the ruin and confusion of all legitimate trade, on the ground that it would be improper to interfere.

87. It is sometimes put, that it would be improper for the Government to interfere, so as to prevent the ryot from obtaining the extra price for his goods which by exporting them to Europe, in the existing state of things, he is now able to do. But this opinion is founded upon a mistake.

88. The reports of the Bengal and Bombay Chambers of Commerce show that up to March, 1877, there was no material rise in the prices paid to the producers. They state that profits were, indeed, made in consequence of the abnormal state of the exchanges by middlemen, whose gains, I may remark, though in the present state of the law, by no means illegal or improper, are nevertheless exactly similar in kind to those of persons issuing debased coins. The present law enables any one to take cheap silver to the mint, to have it coined, and to deluge the currency with rupees cheaper than those now in circulation,—a process which they may continue for years, until the whole currency is depreciated to the lower level. To sanction this process by non-interference is to sanction the degradation of the currency, and loss to the holders of it of the value of 166 millions sterling; besides injury to the rupee creditors of the Government in the same proportion. It must be added, that it is only when it has been so degraded that the ryot will receive an extra price for his produce; and when he does so, his extra price, though nominally greater, will have no more purchasing power than the smaller one.

89. It cannot surely be claimed as a matter of "justice" that the universal desire of the whole native population of India for the restoration of the gold currency* should be refused; or that they should be denied the incalculable advantage, in an urgent monetary crisis, of the power to turn to immediate account the 150 millions sterling worth of gold bullion and coins now lying dormant and incapable of ready use, besides being subject to heavy risks from the constant fluctuations of its market value.

90. Justice can never be infringed by doing one's duty; it may be by neglecting it. It is impossible that any other power, except the Government, could interfere to prevent the terrible losses and misfortunes which have occurred within the last few years, owing to the lamentable unfitnesss of silver to be the standard of value, to a country having the vast and daily increasing commercial transactions India now has with Europe and England, the settling mart of the world. Upon no one, therefore, does the responsibility rest, but upon the Government of India; and to neglect it cannot be spoken of as an act of *justice*, but the contrary.

91. The following extract from an article in the *Calcutta Review*, No. 125, of July, 1876, page 78, illustrates the injustice of the inaction of the Government, from another point of view:—

"For this loss to the country, the Government, which gives the exporter *carte blanche* to have his silver stamped with what has become an artificial value, without exacting from him any equivalent for the addition, is responsible.

"Now, it must strike most persons as a very serious question, whether, on grounds of public justice, the Government is not thus guilty of a grave wrong. The rupee having, by an accident, been rendered much more valuable than the silver contained in it would be without the Government stamp, that Government stamp becomes, *ipso facto*, a trust held by the Government on behalf of the people, which trust it is virtually robbery of the people to betray. It has become, in effect, an order for the surrender of a certain amount of produce without any equivalent return; and to give away that order to any one for the asking, is simply to give him a license to plunder the people to whom the order is addressed."

* The following extract is from the 24th paragraph of the report of the Commission appointed to inquire into the subject. Ordered by the House of Commons to be printed 16th March, 1868. "4th. That the demand for gold currency is unanimous throughout the country."

92. It is stated, by way of excuse, that matters, if left alone, will right themselves in due time; and this was predicted by high authority as the result of the action of economic laws. This may or may not be the case; but if it were, it would be not by the operation of economic laws, but by the legislative action of foreign nations.

93. But even admitting this were likely to occur, it would not in the least degree remove *the inherent evil and mischief* which has been the cause of all misfortune and ruin we have witnessed; namely, the difference of the standards of value of England and India, coupled with the uncontrolled use of the Indian mints; and although its effect may perhaps be somewhat abated for a time, owing to the recent legislation of the American Congress, yet the causes still remain, keeping the exchange the constant sport of events, and ready to reproduce all the distress and misery on the first occasion. It is impossible, however, that India can be kept very long without a gold standard and currency; and to lose the present very exceptional opportunity of initiating that most important change, and at the same time of removing the flagrant evil of the different standards, when it can be done without loss or disturbance, would be a folly and an injustice to our fellow subjects of the Indian Empire, which history will not fail to notice with wonder and disappointment.

As to Interference with the Natural Distribution of the Precious Metals.

94. It has been said that, as there is only a certain amount of gold and silver produced in the world, and as the adoption of a gold currency in India would to a certain extent take from the general supply of gold, and thus tend to increase its value, and diminish that of silver, it would be an impolitic proceeding for a Government, whose revenues are paid in silver, to lend itself to measures which would have the effect of seriously impairing its value.

95. This is a very natural misgiving on the part of a statesman responsible for the safety of the Indian income; but the case may be stated with equal or more truth, so as to lead to a very different, and indeed, opposite conclusion.

96. In the first place, it may observed that the Indian revenues were originally fixed, and are now payable, in "rupees" of a certain definite value, and that that value is threatened with a very heavy decline. That, instead of its being impolitic to adopt the measures proposed, which are designed to securely fix and maintain the present purchasing power of the rupees, it would be in every respect unwise to run the risk of their permanent degradation; and, besides this, that the premises of the objection are untrue, for that the measures proposed would in no respect cause any special abstraction from the supplies of gold to the rest of the world, but, if properly carried out, would produce not the slightest interference with the ordinary distribution of the precious metals.

97. As this point is of importance, and, *primâ facie*, may appear to be incompatible with the provision of a gold currency for India, it is necessary to remind you that, as before shown, a gold currency is not an indispensable accompaniment of a gold standard, and that tokens purchasable only with gold would be steadily worth in the local market the gold paid for them; so that, even if the mints were not allowed to receive and coin gold to meet the constant necessary increase of the currency, but if this were effected by the coinage of silver, as at present, on account of merchants, but through the agency of the Government, at a fixed gold price, all the advantages of an absolute steadiness of the exchange, and maintenance of the full value of the rupee, would be secured, although the automatic introduction of the gold coins might be suspended.

98. But in the mean time we have to consider whether the gold bullion and native and foreign gold pieces already in store in India would not be largely brought to the mints for conversion into coins, if the latter were recognised by law, and available as legal tender for the payment of debts. Ten years ago, Colonel Ballard, Mint Master of Her Majesty's Mint, Bombay, reckoned the quantity of gold bullion in India at 120 millions sterling; and the quantity absorbed since then, that is, the excess of imports over exports, has been considerably more than four millions sterling per annum. Hence, the quantity now in India may be moderately estimated at 150 or 160 millions sterling; and by way of showing the certainty of a large proportion being brought to the mints for coinage, the following passages from some remarks published by Colonel Ballard in 1868, may be quoted:—

99. "This gold should at least form a reserve in a monetary crisis; but it is just at the time of a monetary crisis that it becomes useless, because it is neither money, nor available for conversion into money at the mints. Sovereigns and gold bars are used in many districts for circulation and to adjust accounts; this answers well in easy times. If the owner of gold requires money, he can sell it for rupees. But the more a district has trusted to gold as a circulating medium, the more severe will be the effects of a monetary crisis. Then every one desires to sell his gold and finds that there are no buyers. In almost all other countries the gold could be readily turned into money at the mint. In India this resource is not available."

100. "In 1865 (and on other occasions) when the rate of interest was ten to fifteen per cent., and exchange more than ten por cent. above par, there must have been a store of gold amounting to at least three, perhaps to six, millions sterling, available for coinage within a two days' journey from the mint, where it could have been coined in a week. I am not speaking of gold ornaments, but of sovereigns and gold bars, and hoarded gold, held as a reserve of wealth which would immediately have been brought out to take advantage of the high value of money, and have given great relief to commerce, by reducing the rates of interest and exchange. The monthly imports of gold sometimes reach half-a-million sterling, and, when money is scarce, could be disposed of to the greatest advantage by being passed through the mint."

101. With so large an amount as 150 or 160 millions value already in India, and comparatively useless, as shown by Colonel (now General) Ballard, it cannot surely be an exaggerated expectation to assume that a proportion of this to the amount of, say 30 or 40 millions, would certainly be coined; more especially if the present high charge of twenty shillings for every hundred pieces be reduced, as proposed, to 3s 4d. In addition to the gold coins so obtained, there would be the very large number of sovereigns already circulating in India, which

have been officially estimated to be as many as ten millions.

102. In the present circumstances of India, and considering how very large a proportion of the transactions are on a very small scale, it appears likely that a gold currency of 30 or 40 millions of 10 rupee pieces may be as many as would be required for the convenience of trade; but in addition to this there is the annual supply of gold absorbed by the country, over and above, and quite independent of the balance of trade paid in silver; which gold, whether coined or not, must necessarily be absorbed by India, according to the existing state of things; and which it is next to a certainty will be carried to the mint. This increasing supply of gold is the index and effect of the growing prosperity of the country; and as lately remarked by Professor Jevons, "To attempt to arrest progressive changes of this kind, is vain striving against Providence." The following statement shows conclusively its necessary continuance, and its certain increase :—

103. In the eight years from 1835-6 to 1842-3, the total absorption of gold by India was*		......	£2,180,176
In the 10 years from		1842-3 to 1852-3	9,606,283
Do.	do.	1852-3 to 1862-3	34,149,102
Do.	do.	1862-3 to 1872-3	52,403,967
		Total in 38 years	£98,339,528

104. The above represents the amount of gold which, whether we will or not, comes into India, and will continue to do so, quite irrespective of any alteration in our currency arrangements; and few who examine it with attention will doubt that, with a basis however small to begin with, India would, in the course of a few years, have as large a supply of gold coins as she could have any occasion for, without any alteration whatever of the existing, so to say, natural distribution of the precious metals.

105. But it may be necessary to show, not only as above, that the required gold currency for India may be procured without any alteration of the existing distribution of the precious metals throughout the various countries of the world, but also that it certainly will be so supplied. Or rather, if it should be thought of importance to prevent the possibility of such interference, to inquire what measures can be taken to provide that it does not take place in the slightest degree.

106. The answer to this question is that the tendering of gold to the mints, and the choice between Council bills and gold as means of procuring rupees, wholly depends upon the price at which the former can be obtained. The additions to the Indian currency are almost wholly made by the banks and a few of the wealthiest merchants, and the object invariably is to obtain the currency in the cheapest possible manner. According to existing rates, there could be no advantage gained by sending gold bullion or sovereigns from London or Australia to India in return for produce sent to Europe, instead of purchasing telegraphic transfers at 2s. the rupee; but, if under certain conditions, any slight benefit were to be had, this would be at once put a stop to by reducing the price of the bills to 1s. $11\frac{7}{8}$d., or, in an extreme case, to 1s. $11\frac{3}{4}$d. per rupee. It would, therefore, rest entirely with the Indian Government, if it were thought necessary to prevent the possibility of any disturbance of the distribution of the precious metals throughout the world, owing to gold being brought to India for currency purposes, to take no other step than that of reducing the price of the bills accordingly.

* Miscellaneous Statistics relating to the Finances of British India for 1875, Account. No. 93.

The Rate of Exchange.

107. A few words have now to be said as to the proper rate of valuation of the rupee as compared with gold, and I would begin by remarking that no other ratio than 2s. the rupee can possibly be chosen. The advantages of it are so great that, even if it required some little distortion of the true value to bring it about, it would be a never-ending reproach to our statesmen if they were to adopt any other.

108. For, in the first place, it must be remembered that, in so far as commerce is concerned, it is absolutely unimportant what rate is fixed. After due notice commerce would adapt itself to any rate without inconvenience, so long as, when once settled, it was not liable to sudden fluctuations. Secondly, it will be allowed that in order to rectify the great disturbance which has taken place in the currency, it would be indispensable to restore it to what it was on the average *before the disturbance began*, that is, to the average value which it possessed previous and up to 1873.

109. Now, if we examine the Statement, No. 164, given with the miscellaneous statistics relating to the finances of India, part 3, 1875, we shall find that for the 20 years preceding 1873 the average rate of the Council bills, after allowing for the 60 days' discount in India, was a trifle above 2s. the rupee; and if the inquiry be extended further back, the rate would be much higher.

110. We have, therefore, not only the propriety and incalculable convenience of the proposed rate of 2s. the rupee to plead in its favour, but also the inexorable claims of justice to be attended to in making full reparation of the damage caused by the accidental events of the past few years; and the further obligation to guard the interests of the native taxpayers, by keeping up the full value in the markets of the world of the contributions levied from them.

Forgery and Unlawful Coinage.

111. This objection has been very fully treated in the fifth essay above referrred to,* and it will therefore be only slightly noticed here. As regards the imitation of good rupees in base metal, which is the ordinary form of fraud on the coin, it must be remembered that the temptation to this has always existed, and will not be at all increased. But although it is comparatively easy, no difficulty has been experienced on account of it hitherto. In regard to the unlawful coinage of good rupees from standard metal, it must be explained that this is a very difficult operation, and is purposely made so, as will be understood when it is stated that the "blanks" or discs of metal from which the rupees are stamped are less than one-sixteenth of an inch thick, and from this thin plate of tough metal the raised intaglio of the Queen's head on the obverse

* Vide § 58.

and the device on the reverse have to be produced by a single blow. The consequence is, that genuine rupees cannot be manufactured in numbers economically, without expensive machinery and a large establishment of workmen, the cost of which totally forbids the hope of profit, unless successfully carried on on a very large scale; and the idea of their being so manufactured in India, without the knowledge of the Government, is as absurd as the notion that a manufactory of steel rails could be worked in secret in the highlands of Scotland or in Wales.

112. As for their being manufactured in Europe or America, and smuggled into India, it must be borne in mind that if it were possible to any extent, however great, short of the whole required import, the only harm that could come of it would be the loss by the Government of the seigniorage or gain by coinage, just as they would lose the tax on any other smuggled article. There would be no other inconvenience whatever; and although it would be not impossible that now and then a few pieces could be unlawfully introduced into India, if they could be profitably made for the purpose, yet it seems ridiculous to suggest the apprehension that such an enterprise should be attempted on a large scale, or that any notable proportion of the 50 millions of rupee pieces, or more than 500 tons in weight, could, year by year, escape the vigilance of our custom-house officers at the few ports where they could be landed.

The Costliness of a Gold Currency.

113. When the Government of India refused the request of the Bengal Chamber of Commerce to close the mints to the coinage of silver on private account, it was given as the opinion of His Excellency in Council, that there was nothing in the nature of existing circumstances, notwithstanding the inconveniences and anxieties they undoubtedly involved, demanding recourse to a measure so costly, and of which all the requisite conditions were so uncertain, as the free coinage of gold.

114. This had reference, doubtless, to the supposed difficulty, or rather impracticability, of procuring sufficient gold to form an ample currency for the wants of India, thereby in a great measure displacing the rupees; and having in view the highly unsatisfactory attendant results of the German measures for that purpose, there can be no wonder that not a little hesitation was felt before entering upon such an apparently vast and critical undertaking. But it may be hoped that the explanations given in an earlier part of this paper* will be sufficient to place it beyond doubt that the required change may be effected without the smallest outlay. On the contrary, that the restoration of the exchange to its normal figure of 2s. the rupee, would be attended with a very large permanent improvement of the Indian finances, to the amount of not less, probably, than a million sterling per annum.

115. As to the confusion which some have supposed would attend the proposed measures, it is very difficult to imagine what can be meant; because the only change from the present routine would be that merchants and the banks having occasion to procure the Indian currency, instead of doing so partly by purchasing silver bullion and sending it out for coinage, and partly by the purchase of Council bills, would in future procure it by the latter means only. This change would be unobserved and unknown to the natives of India, and the only other change, viz., the concession of the privilege of having their gold coined, would be availed of without any confusion.

116. With regard to individual losses, it seems to be hardly possible that there could be even the shadow of an excuse for any complaint on that score. By a proper allotment of the quantity of bills drawn upon the Indian Treasury, after the coinage of silver was suspended, the rise in the rate of exchange would be far more gradual than such as might be caused by the resolution of a foreign Government to make an extensive use of silver in coinage; and it is unreasonable to suppose that an alteration in exchange, which could be brought about with comparative suddenness by a foreign State, without affording the slightest cause for protest, or claim for compensation, could be objected to when carried out, at the request of the merchants, and in the interests of commerce, with the most patient consideration.

117. Supposing, however, that there were cases in which it was possible to show that an individual had suffered loss by the action of the Government, the grant of the most ample compensation would be as nothing in comparison with the advantages of establishing the Indian currency on a firm and immovable basis. Even half a million sterling disposed of in that way would be but a fraction of the pecuniary gains which would be set against it in a short space of time.

Concluding Remarks.

118. It only remains to be explained, that the measures which have been proposed in the early part of this paper may be brought into operation, without even the very slightest disturbance or excitement; or indeed any alteration, except the gradual rising of the rate of exchange. Also, that they might be adopted temporarily, and at any moment abolished, and the present system reverted to, if any evil consequence were experienced.

119. They involve a principle which, it is hoped, will on full consideration be admitted to be correct, viz., that the value of a currency depends upon its cost as a whole, not necessarily on the individual value of the separate pieces. If this be true, then the problem, not of the double standard, but of the double currency, is solved; and, in India or elsewhere, a double co-equal currency of gold and silver coins, the latter paid for by gold, would circulate freely together without inconvenience.* If

* Vide §§ 35, 47, and 104.

* The following illustration will explain the principle here referred to. Suppose the British standard and currency had been for generations established upon gold, the produce of California and all other parts of the world except Australia, and that suddenly new mines in the latter place were discovered, which produced the metal 25 per cent. cheaper than former supplies; that is, that every sovereign could be had for the same cost as 15s. formerly, but the actual rate rather variable. Suppose, further, that the Legislature, unwilling to sanction a great loss to the holders of property based on previous values, were to pass a law putting a variable tax on the export of gold from Australia, equal at all times to the difference between its cost and that of the gold of the rest of the world, the effect would be that the British sovereigns so obtained would be constantly regulated in value by that of the older sovereigns; and there would thus be only the one, the former standard for coins of both metals. Substitute silver for Australian gold in the above example, and the *rationale* of what may be called the "Bi-metallic single standard" will be easily understood.

it be objected that occasionally the silver coins would accumulate in single hands and be very troublesome, the answer is, that that is one of the very evils which a gold currency would in a great degree correct; and the natives of India, however much they might suffer from it, would be no worse off—indeed, they would be very much better off—than they are now. It has been, however, proposed hereafter to limit the legal tender of the silver coins; though it would probably not be desirable to restrict them to the same extent that they are in England.

120. These remarks have now come to a close; and in expressing my unfeigned appreciation of the great privilege which has been afforded me of bringing this subject to the notice of the Society, I wish to explain that I should not have presumed to do so, but for my very strong persuasion of its importance.

121. I have myself not the slightest doubt that every misgiving and apprehension connected with the suggested remedy will be dissipated by a thorough investigation; but, as yet, it has not attracted the careful study it requires; nor, so far as I am aware, received any official examination. The very large benefits it offers justify the demand for this at the hands of Indian statesmen, and I trust it will soon be granted. If not, the approval of this Society cannot but form a most powerful, if not irresistible, claim to their attention.

DISCUSSION.

Mr. Frederick Hendriks said:—I believe I have read all that Colonel Smith has published on the rupee question, and on the introduction of a gold standard into India, by stopping the mints there from coining any more silver rupees, and selling Council bills at an enhanced rate of exchange; and although I fully appreciate the ability and unwearied industry with which Colonel Smith has propounded his plans, and gained notice of them both in England and in India, I must confess that individually I see objections, which seem to me insuperable, to their being carried out.

The ultimate object of Colonel Smith is to introduce a single gold standard into India in the place of a single silver standard, with a 10-rupee gold piece of the exact weight, fineness, and value of the English pound sterling, and with the continuance of the silver rupee at its present weight and fineness, but with the value levelled up to the exact sum of 2s., or one-tenth of a 10-rupee gold piece, or English pound sterling. The silver rupee would therefore contain, as it does at present, 165 grains of pure silver, and the gold rupee would contain 113·0016 grains of pure gold, giving a ratio between the two metals of 14·60157 silver to 1 gold, or a price of 64·582d., say $64\frac{9}{16}$d. per ounce of English standard silver, and an intrinsic mint par of exchange of 24d. per rupee.

I do not at all agree with Colonel Smith that because in the 20 years preceding 1873 the average rate of the Council bills, after allowing for the 60 days' discount in India, was a trifle above 2s. the rupee, it will, therefore, be just, although it would be convenient and agreeable to most of us no doubt, to make the rupee of the future 2s. Against what Colonel Smith calls (see paragraphs 109 and 110 of his paper) the inexorable claims of justice in this regard, I am afraid that we must place the inexorable logic of the fact that, in any adjustment or alteration of a national standard of value, equity demands that the relative intrinsic value of the metals, gold and silver, contained in the coins shall alone be considered.

The adoption of the gold value of 2s., 24 pence, or one-tenth of a sovereign, as proposed by Colonel Smith, quite disregards the fact that the intrinsic gold value of the silver contents of the rupee now in circulation, which was established by Act XVII. of 1835, passed by the Governor-General of India in Council on the 17th August, 1835, gives, as I will presently explain, a mint par of intrinsic value in exchange of about 1s. 10d. or 22d., and not 24 pence per rupee. Colonel Smith's plan, therefore, increases the gold value of the rupee by one-eleventh part, or, in other words, by 9·0909, or, say $9\frac{1}{10}$ per cent. on its intrinsic value of 22 pence.

As I have already explained, if we make the gold value of the rupee 24 pence or 1-10th of a pound sterling, as Colonel Smith proposes, the ratio of gold and silver implied by such a valuation would be 14·60157 silver to 1 gold. Let us, therefore, examine what would be the gold value of the rupee, taking first the ratio in use in those countries of Europe where legislation has attempted a double standard during the whole of what has passed of the present century, namely, the ratio of $15\frac{1}{2}$ to 1, and, secondly, the ratio in use in America of 16 to 1, as established in her coinage reform in 1834 (*i.e.*, only a year before the Indian coinage reform of 1835), continued down to 1873, and just renewed in the legislation of 1878?

At $15\frac{1}{2}$ silver to 1 gold (the European mint ratio for the double standard), the intrinsic value of the rupee comes to 22·608662 pence, say $22\frac{3}{5}$d. And, at 16 silver to 1 gold (the American mint ratio), the intrinsic value of the rupee is 21·902335, say $21\frac{9}{10}$ pence.

Therefore, at the ratio between silver and gold of $15\frac{1}{2}$ to 1, the equivalent gold price of silver, per English standard ounce, may be calculated at about $60\frac{7}{8}$d.; and at the ratio of 16 to 1, the equivalent gold price per ounce, at about $58\frac{7}{8}$d. These differ widely from the $64\frac{9}{16}$ pence per ounce, which, as I have already stated is involved in the conditions of Colonel Smith's plan for a rupee of 24 pence gold value.

The question, then, arises—has $64\frac{9}{16}$ pence per ounce standard been, at any time since the year 1835, when the rupee coinage was consolidated in India, the gold price of silver? The answer is—Certainly not. In July, 1859, it touched the highest price it ever attained since 1835, namely, $62\frac{3}{4}$d. per ounce, but anyone who will take the trouble I have done to ascertain average prices of silver over a long course of years, will find that, on the whole, down to a very recent date, the price was steady with very inconsiderable deviation from the prices which ruled in 1834 and 1835, when the American and Indian coinage reforms took place.

The average price of the two years 1854–35 was $59\frac{13}{16}$d. per ounce. The average price in August, 1835, when the Indian Coinage Act was passed, $59\frac{1}{4}$d. per ounce. The average price for 10 years, 1836–45, was $59\frac{7}{16}$d.; for the next 10 years, 1846–55, it was $60\frac{3}{8}$d.; for the next 10 years, 1856–65, it was $61\frac{3}{8}$d.; for the next 10 years, 1866–75, it was $59\frac{13}{16}$d.; and for the last 2 years, 1876–77, it was $53\frac{3}{4}$d. If it be said that these averages include certain years that have been exceptionally and abnormally subject to depression, it may be said, with equal correctness, that rather a larger number of years is included in them of similarly exceptional and abnormal rise in the silver market. However, grouping the results in periods of years, we find that the average for 10 years, 1866–75, showed no decline, but on the contrary an advance upon the price of 10 years succeeding the Indian coinage reform, 1836–45.

It becomes interesting also to collect the results into one average for the 42 years, 1836-77, which will be found to yield an average price of 60 pence of gold value per English standard silver ounce. Now, at 60d. per ounce, the intrinsic value of the rupee is 22·29653, say $22\frac{5}{16}$d., per rupee, as against Colonel Smith's 24 pence per rupee at $64\frac{9}{16}$d. per ounce, and a ratio between silver and gold of 15·717 to 1, as against his 14·60157 to 1.

When a nation finds it desirable to change its standard of value from one metal to another, it can only adjust the vast outstanding contracts, that have been made at any dates between the institution and the change of the standard, by considering two factors, firstly, the price of one metal as measured by the other at the time when the standard was instituted, and, secondly, the average price at which one metal has measured the other during the whole time that has elapsed between the institution and the change of standard. And, as I have already shown, the price in gold of an ounce of standard silver was, at the date of the existing rupee coinage being instituted, $59\frac{1}{4}$ pence, whilst its average value for the 42 years following that date, down to the present time, comes out at 60 pence. The alteration has therefore amounted to no more than three farthings per ounce, or to $1\frac{1}{4}$ per cent. increase on the price in 1835.

Subject to the explanation I have given, I hold that the only factors that ought to be taken into consideration, assuming that a change of standard in India were now to take place, are the preceding figures of $59\frac{1}{4}$ and 60 pence per ounce, as the prices of silver, which would preserve on the average the *summum jus*, the strictest equity, of every intermediate Indian transaction, public and private, in the change from silver to gold prices. And it was on such considerations as these that in March, 1876 (see *Journal*, vol. xxiv., p. 351) I then submitted for the consideration of this Society a plan of gold coinage for India, in which the 10-rupee gold piece was to be coined of a weight $\frac{1}{11}$th less than the English sovereign, *i.e.*, to contain 112·06770 grains standard, and 102·7287 grains pure gold. The 10-rupee gold piece would then be worth $\frac{10}{11}$ths of one pound sterling, and 11 rupees would be worth one pound sterling, the value of the rupee coming out a trifling fraction under 1s. 10d. And the equivalent price of silver per ounce being 59 pence, the result—in my judgment—is to adjust the gold coinage at a price which, considering that the market for silver has now for five years been a falling one, is not only fair, but also very consistent with the price when the rupee coinage was instituted, and the price at which it has ranged in the last 42 years. Those two factors, of $59\frac{1}{4}$ and 60 pence, viewed in conjunction with an existing price of between 54 and 55 pence, are to my idea a justification for my average adjustment at about 59 pence per ounce, or 1s. 10d. nearly per rupee, as contrasted with Colonel Smith's adjustment of $64\frac{9}{16}$ per ounce, or two shillings per rupee.

I hold, therefore, that if India were to adopt a gold standard on the plan I had the honour to explain to this Society on the 7th March, 1876, there would be no loss to the average debtor and creditor in India from the standard being changed from silver to gold, and that Colonel Smith is, in my opinion, mistaken in saying, in the remarks in his present paper, that a large loss would arise from my plan. It would, truly, if the rupee were now, or had been since it was created in 1835, worth 24 pence of gold, but I have proved that its intrinsic gold value has on the average been 11 per cent. below that. On the contrary, it is Colonel Smith's plan, and not mine, which would require a tariff of re-adjustment for contracts in the old silver rupees expressed in the new gold rupees. My plan would act without a tariff, like in the changes from a silver to a gold standard, which have taken place in very recent years in Germany, Scandinavia, and other countries. But Colonel Smith's plan would intrinsically decrease all prices and all debts by about $\frac{1}{11}$ say $9\frac{1}{10}$ per cent., whenever new gold prices have to be quoted in India, instead of old silver prices. The revolution in prices which he mentioned, would occur accordingly by the working of his plan and not in any way from that of mine.

In the next place, I should object to the principle of Colonel Smith's plan of setting up a silver token coinage composed of present silver rupees, at so expensive a ratio as his plan would involve, of 14·60157 silver to 1 gold, that being the equivalent of 24d. per rupee, or $64\frac{9}{16}$d. per ounce of silver. In England, the token ratio is 14·287, in Italy, France, Belgium, and Switzerland, it is 14·464. The members of the Society will recollect that, according to my own plan, the Indian silver token currency would be coined in rupees of the worth and weight of $\frac{10}{11}$ths of a florin each, just as the gold rupees would be coined of the worth and weight of $\frac{10}{11}$ths of a sovereign each. Every 100 millions sterling worth of silver rupees in my plan would be 11 per cent. less in pure silver, weight, and value, than at present, and thus save 11 millions of needless cost to the Government and people of India, as compared with the expense of Colonel Smith's plan.

My third objection to Colonel Smith's plan is, that it would introduce an imperfect double standard into India for an indefinite time, and that it would be likely to be a long term of years before it could substitute a gold standard for a silver one, even if the plan were not otherwise objectionable.

My own plan for the introduction of a gold standard into India would, as I explained to this Society in March, 1876, be an open and avowed one, with exact conditions laid down at the outset, and making the double standard permissible only as a temporary measure, to cease absolutely at the end of five years, during which the Indian Government would have to buy gold, just as the English Government had to buy gold in 1816, when the single gold standard was introduced into England, and just as Germany, Sweeden, Denmark, and Norway, and Holland have had to do in 1873-8, in their charges towards a single gold standard. My plan could not require anything beyond the application of general principles, which have been found sufficient for the purpose in other countries. Colonel Smith's plan would require the trial of an experiment of a doubtful and retrograde nature. It would amount, indeed, to a very serious and arbitrary interference by the Government of India with the natural course of trade and of the practice and theory of legislation on coinage and the standard of value. The adoption of so martial a remedy as the influence of the pressure of the Government itself, in forcing up the price of its existing standard of value by a measure of monopoly and restriction, has more of the look of sixteenth and seventeenth-century mint legislation than of the present era. The example of France and of its monetary allies of the Latin Union in stopping, or nearly stopping, the coinage of more silver in the last few years, is not at all an example which India is in a position to follow. France possessed an enormous amount of gold coin in circulation; and debts were habitually discharged, and had been for many years settled, in gold, before she ventured to stop the mint to the coinage of silver for individuals, at first partially, and now absolutely. The character of the circulation of metallic legal tender in France may best be understood, when consideration is given to its altered condition, and to the fact that whilst in the year 1860 the Bank of France had only four millions sterling worth of gold in its reserve, it had 13 millions sterling worth of silver, so that the distribution of the metals was then 24 per cent. gold and 76 per cent. silver, whereas in 1877 it had 65 millions sterling worth of gold and 22 millions of silver, *i.e.*, 75 per cent. gold and 25 per cent. silver. The relative position of the two metals, in the actual circulation and in the reserves for banking and hoarding, had in point of fact quite reversed themselves before France, historically instructed as to the evils of a double standard, in its everlasting see-saw action of change and uncertainty upon the two measures of value, gold and silver, put an end to the risk of being flooded by the depreciated metal for the time being, silver, by stopping the mint to the influx of that metal.

The gold coin struck in France in the quarter of a century from 1851 to 1875 has, in point of fact, amounted to 6,743 million francs, and the silver to 764 million francs. The coinage of gold has, therefore, been nearly

nine times as great as that of silver. The proportion was even larger, namely, more than 10 to 1 of gold coined to silver coined from 1851 to 1873 inclusive, *i.e.*, before the first partial stoppage of the French mint to silver coinage in 1874.

Col. Smith, in his criticism in his present paper of my plan of 1876, observes that he does not see how the rupees of the new coinage could be put into circulation conveniently with the old. Such a thing has, however, been accomplished in many countries during the changes they have had to make in their coinage from a full-valued metallic circulation to a circulation of the subsidary metal in a token form. It was done in England in 1816, when the shilling, which used to be coined at 62 shillings to the pound weight of silver, came to be coined, as it is now, at 66 shillings to the pound weight of silver, and its legal tender restricted to the sum of two pounds in any one payment. The same thing is now being dono in Germany and with a similar object, the legal tender being restricted to about the value of one pound in any one payment. Other Continental countries have acted in the same manner, upon making changes in their metallic circulation, without necessity for establishing tariffs of compensation during the transition period, when the difference was not great between the old and new coin. I never intended, however, that my plan, merely sketched in outline to this Society, in March, 1876, should not include some tariff of compensation to the holders of old rupees in India on bringing them to the mints for re-coinage into new rupees. On the full weighted pieces there would be a difference of intrinsic value of 11 per cent., and on the pieces only just coming within the degree of wear entitling them to legal circulation, there would be a difference of 9 per cent. The average difference would thus amount to 10 per cent. This I would divide as follows between the holders of the rupees, the *beati possidentes*, and the Indian Government, giving the former the lion's share as a stimulus and inducement for their promptly bringing the old rupees to the mint for re-coinage within five years. To the holders, then, I would give a premium or *batta* of one anna per rupee, *i.e.*, 1-16th more in new coin than the nominal amount of the old coinage presented for re-coinage. This is the same *batta*, 1-16th part, *i.e.*, $6\frac{1}{4}$ per cent. that was allowed in the conversion of the Sicca rupees into Company's rupees in 1835. A tariff was then required in India for conversion of old debts into new currency, and *vice versa*, in the adjustment of new prices and rents in the new currency, because, although the silver standard was unchanged by the coinage reform, it diminished the pure metal contents of the Sicca rupee by no less than 1-16th part. But in my plan no such tariff would be required so soon as the five years' notice shall have expired, and the whole circulation put upon a gold basis. Prices would then all be gold prices. Debtors and creditors would all pay and receive upon a gold basis, which, having, as I contend for my plan, been settled upon a true intrinsic comparison of the respective values of gold and silver—*i.e.*, upon the 10-rupee piece of gold, containing 102·7287 grains troy of pure gold, and not 113·0016 grains troy, as Col. Smith would coin it—would be a true adjustment (as I have explained in the first part of my remarks), upon the triple consideration (1) of the value of gold compared with silver at the time when the existing silver rupees were first instituted in 1835, (2) of the relative values of gold and silver in the 42 years from 1836 to 1877 inclusive, and (3) of the fact that the silver market has of late years been a declining one. It is, therefore, Col. Smith's own plan, and not mine, which would require a tariff for adjustment of debts and contracts previously entered into; and his plan, and not mine, which would make a revolution, as he terms it, in prices of commodities.

I have so far explained that, in my plan, $6\frac{1}{4}$ per cent. out of the average surplus value of 10 per cent. silver in the present, as compared with my proposed, silver rupee coinage would go to the holders upon their importing the coin into the mint for re-coinage. This would leave $3\frac{3}{4}$ per cent. for the Government, who would, on this occasion, leave out of consideration during the five years covering the proposed re-coinage, their customary charge of 2 per cent. for seignorage. The whole of this $3\frac{3}{4}$ per cent. would, therefore, be so much gross gain to the Government, out of which to defray the expense of re-coinage. There would be left a large surplus to be applied towards the premium and expenses of purchasing gold coin and bars for coinage of a sufficient stock of 10 and 5 rupee pieces to provide for an exclusive gold standard at the end of the five years, and for a double transitional gold and silver standard during the period of five years.

The larger the number of silver coins presented to the Indian mint for re-coinage, the greater would be the surplus thus available; for instance, if 1,000 million rupees' worth were re-coined, there would be a gross available fund of $37\frac{1}{2}$ million rupees. It will be recollected that in my plan one of the conditions was, that if the rupees of the present weight were not presented by the holders for re-coinage within five years, the latter would be dealt with as was done with the holders of Sicca rupees in 1835-38, when it was ordered, in 1835, that from the 1st of January, 1838, they should cease to be a legal tender, though receivable by the collectors of inland revenue and at the public treasuries by weight, and subject to a charge of one per cent. for re-coinage. This charge would, of course, be in addition to the $3\frac{3}{4}$ per cent. reserved to the Government on the operation of re-coinage. This might perhaps reduce the current commercial batta, or premium, on the old rupees in circulation after the five years, but no general inconvenience could arise from that, any more than now arises from the varying premium in India now existing on sovereigns, gold mohurs, old Sicca rupees, and other coins not having an obligatory legal tender.

I have thus far endeavoured, so far as the pressure of engagements has enabled me to consider the subject, to remark upon some of my objections to Colonel Smith's plan, and of the paper he has just read, and which he very kindly gave me the opportunity of seeing a week ago, so that I might have a little time for reflection. It has naturally been my duty to defend, on the present occasion, a good deal of what I brought before this Society on previous occasions. In conclusion, and in thanking you, Mr. Chairman, and the meeting, for the patient hearing of my explanation, necessarily, as all such subjects are, dry and technical, I should like to say that I think Colonel Smith's estimate, based although it may be on Colonel Hyde's opinion of the figures, which puts down the total present silver rupee circulation of India at a value of 180 million pounds sterling in value, is, in my opinion, largely in excess of what any fair deduction from the statistics would seem to warrant. The total coinage at the mints in India for the 41 years, 1835-6 to 1875-6, is, according to the official returns, equal in gross value to £213,211,429. From this have to be deducted re-coinages of old rupees. The true amount of these old rupees re-coined does not appear to be known, except as regards the amount, chiefly of Sicca rupees, bearing dates previous to 1835, the year of the coinage reform. The total amount for the 41 years of the latter description of old coinage re-coined is put down as worth £21,457,534. This would reduce the gross £213,211,429, before mentiond, to £191,753,895. The amount of deduction to be made for the loss and wear, and destruction of this silver coin circulating, without the aid of gold as an aid, and saving of its constant use, amongst some 200 millions of people in the 41 years, must be something very great. Then, if we reckon the rupee at its present worth, a very large deduction must be made from the £191,753,895 which is computed at two shillings per rupee. I must still insist upon the view taken by me on the former occasions of discussion of the subject (see *Journal of the Society*, vol.

xxiv., p. 350) that, in this large series of now 42 years since the coinage reform of 1835, a sum of enormous magnitude out of the coined rupees must have been melted down into the bangles and personal ornaments worn by the natives generally, and for use as bullion in the arts. The amount so applied in personal ornaments, and to other purposes than the metallic circulation of India, must have largely increased in those periods when wages were high, and the surplus available for hoarding, in other ways than by the accumulation of coin, greater than at former periods. Putting all these qualifying circumstances together, I do not think that 180 million pounds sterling worth of active silver circulation of rupees would be affected by the change of standard, but that 100 million pounds sterling worth is much nearer the value. As far as regards the stock of gold that would be required in adopting a gold standard, I quite agree with Colonel Smith that the large supply of gold already in India, and the amount of gold which annually flows to that country in the course of trade, would abundantly supply a gold coinage for India, without creating any disturbance of the natural distribution of the precious metals throughout the world.

Mr. K. M. Dutt said—I beg to offer a few remarks upon the most valuable paper read this evening by the gallant gentleman, upon a subject of great importance to the Government and people of India. The recent fall in the value of silver is not due (as is generally supposed) to the increased production of this metal over that of gold, as the carefully-prepared estimate of Sir Hector Hay showed that the aggregate production of silver throughout the world, from 1852 to 1875, was only £241,890,000, while that of gold was £572,195,000. Neither can the demonetisation of silver in Germany alone account for it. The total value of the silver coins in circulation at the commencement of the coinage reform has been calculated, by reliable authorities, to be about 45 millions, deducting 22½ millions for new coinage, this would leave only 23½ millions as surplus stock for sale, which would have been soon absorbed, but for the simultaneous decreased demand for silver for Norway, Sweden, Holland, and the members of the Latin Union. These causes, operating together, must have caused this serious fall. The silver currency being the standard in India, and the Government being bound, by the Act 23 of 1870, to receive silver from and coin for private individuals, any depreciation in the value of that metal must necessarily cause a fall of exchanges on India. It will not, however, have any permanent effect on Indian trade, as the balance of trade has been always in favour of India. The total export of India (merchandise only), from 1855 to 1875, is about 933 millions, and the import (excluding treasure) 545 millions, leaving a balance of 388 millions. Of this sum India has received 250 millions (gold, £87,669,382; silver, £162,602,672) in treasure. The rest—say about 138 millions—must have been expended in this country, and as, during this period, various large sums have been sent, from time to time, from this country by railway and other companies (which are included in the said 250 millions) for their expenses in India; I believe the expenditure here must have been considerably more than that sum. Had there not been these heavy home charges, the fall in the value of silver would not have injured much the Indian trade, as the increased flow of silver, having increased the price of commodities in India, would soon have brought about an equilibrium. Now, this home charge (nearly 15 millions per annum), causing a loss of about three millions, is the most important element in reference to the question of exchange between England and India. Until it is reduced we must not expect to see any rise in the rate of exchange. But this reduction is not a very easy problem. The remedy proposed by Col. Smith, viz., a gradual introduction of gold currency, is no doubt a good one, but its administration will not be found very easy. This ought to have been done before, when the rate of exchange was higher. From 1855 to 1875, the Government of India coined silver rupees, valued 142 millions, whereas gold coined during that period valued only about one million. Now, where are we to get the gold from for coinage? To buy it from foreign markets with our depreciated silver money would involve a serious loss. It is very doubtful whether such a large amount of gold as of value 30 or 40 millions would be available in India, as stated by the reader of the paper, for this purpose, as the greater portion of gold in India is now in the form of ornaments and idols. It is, however, much easier to criticise a plan than to propose a new one. Nevertheless, I shall venture to suggest that, concurrent with the remedies proposed by Col. Smith, viz., suspending the silver coinage and introducing gold currency, the adoption of the following measures:—1. To reduce the expenditure in this country. 2. To meet the home charges for a limited period—say, four years—with money raised here by loans. 3. To apply 15 crores of rupees a year (which now meet the Council drafts in India) towards reducing the debt in India. Borrowing money in England for home charges, while it will reduce them by three millions (loss by exchange) per annum, would not increase the debt of the Indian Government, as the same amount of debt will be reduced in India. Thus there would be a saving of 12 millions in four years. In the meantime, 20 millions per year—the balance of trade—will be remitted to India in gold. If three-fourths of this gold be coined into 10-rupee pieces, it will give India 60 millions of gold currency. This increased gold currency will not fail to produce a permanent favourable effect on the rate of exchange on India. The next thing is to reduce the home charges. That is the most important item and the most difficult; no doubt the greater portion of them are legitimate expenses in paying interest on money already borrowed. There is a double loss at the present time which economists do not sufficiently take into consideration, because when a country has to remit a certain amount of money annually to another country which should be paid by its exports, the value of the exports is depreciated, and the loss is doubled.

Mr. Foggo said he had one question to put, of rather a practical nature, not scientific or technical. He had only seen the paper that evening; and even if he were competent otherwise to discuss it, that fact would prevent his doing so. He would call attention to paragraph 21, where Colonel Smith mentioned the Right Hon. Sir James Wilson as an authority for the introduction of the gold currency, instead of silver, Now, unless his memory deceived him very much, that gentleman was almost dead against the introduction of a gold currency. He said that if he had to begin *de novo* he might prefer gold to silver; but he objected to gold being introduced into India on several grounds; one, what might be called the breach of credit ground; another, that it was not applicable to such a country where the people were poor, and the majority of transactions were very small. He believed there were other reasons, which he did not remember for the moment.

The Chairman hoped that Colonel Smith, when he replied, would refer to one point which he had not touched upon, but which seemed to him of some importance, namely, what effect would the stoppage of the coinage of silver in India have on the trade between that country and China. That trade was exceedingly important, it averaged about 15 millions sterling, against an average of 20 millions between China and the United Kingdom, and he could not but fear that the stoppage of the silver coinage would disturb the trade very materially.

Colonel Smith, on being called upon to reply, said that, as regarded Mr. Hendriks' remarks, he could not answer the numerous statements and calculations without time for examination; but that it struck him, at once, that probably the difference between himself and Mr

Hendriks might be explained by the fact that, owing to an oversight, Mr. Hendriks had taken only the London price of silver bullion, and omitted to take into account the freight and insurance which make up the Indian price of the silver, besides the interest of money and the "seigniorage" or mint charges for coinage of the rupee. In other words, that he had adopted the "intrinsic par" instead of the "commercial par," which latter regulates the value of the currency. Bankers and merchants, whose business it is to procure the Indian currency, are well aware of these charges, and allow for them in estimating its value. He said that, in consequence of this omission, together with the operation of certain facts which could not have been known to Mr. Hendriks, the whole of his calculations required modification; and the effect of the modification would be to remove the objections founded upon them. He did not think it necessary to trouble the Society by minutely criticising all the calculations; only one need be noticed, that being the basis of Mr. Hendriks' first and most elaborate objection to the paper, namely, that the rate of two shillings per rupee is too high, and ought to be 1s. 10d. This objection he would state in Mr. Hendriks' own words, which were these:—"Subject to the explanations I have given, I hold that the only factors that ought to be taken into consideration, assuming that a change of standard in India were now to take place, are the preceding figures of $59\frac{1}{4}$d. and 60d. per ounce, as the price of silver, which would preserve on the average the *summum jus*, the strictest equity of every intermediate Indian transaction, public and private, in the change from silver to gold prices." Mr. Hendriks having stated in his previous remarks that $59\frac{1}{4}$d. per ounce was the price of silver for the month of August, 1835, when the present Indian currency was established, and 60d. per ounce the average of the 42 years from 1836 to 1877, Colonel Smith observed that, as it was most highly improbable that the Government of India would base the future currency of the Empire upon the accidental price of one month, and as the average price of the two previous years was $59\frac{13}{16}$th per ounce, it seemed to him more correct to take this latter, as stated by Mr. Hendriks himself, as the true price of silver at the time the present Indian currency was established. Mr. Hendriks, taking $59\frac{1}{5}$d. per ounce as the price of silver, brought out the value of the rupee at 22d., but in doing so omitted to reckon the freight of the bullion, which in 1835 was round the Cape of Good Hope, a four months' voyage, also the cost of insurance, the loss of interest, and the coinage charges. Long after 1835, namely, in 1864, when by the Peninsular and Oriental Company's steam vessels the communications between England and India were immensely superior to those of 1835, Mr. Dunlop* stated these charges to be $3\frac{1}{4}$ per cent. upon the value, besides the seigniorage. Compared with this, the charges in 1835 could not have been less than 6 or 7 per cent. besides the seigniorage. Colonel Smith then mentioned the facts he had before referred to, which could not have been known to Mr. Hendriks, namely, that in 1834 the seigniorage or mint charge for coining silver bullion was in Calcutta 2 per cent. plus extra charges for refining; in Madras 3 per cent.; and in Bombay 4 per cent., without extra charges. Taking all these expenses into consideration, the value of the rupees previous to 1835 must have been on the average 8 to 10 per cent., including seigniorage, beyond the cost of the silver bullion composing them, thus making the value of the rupee from 24d. to nearly $24\frac{1}{2}$d., when the London price of silver is $59\frac{13}{16}$d. per ounce, instead of 22d., as Mr. Hendriks, taking the price at $59\frac{1}{4}$d. per ounce, had supposed. He added that there was another way in which the value of the rupee, at the time the currency was established, may be estimated Some years previous to 1835, the Government of India fixed the ratio of gold to silver at 15 to 1, and the gold coins were altered to correspond with that ratio. Allowing an average mint charge of 3 per cent., this gives the value of the rupee at 24·02d., reckoning gold at 933d. per ounce. He said that, to avoid any doubt as to the propriety of reckoning similar charges for the gold coins, he would explain. 1. That the comparison is between rupees in India and the English currency to be exchanged by telegraphic transfer. 2. That the cost and value of gold is the same, or, if anything, less in India than in London. 3. That the sovereigns, as well as the proposed new gold coins, are struck without any seignorage or mint charge. He said that it was important thus to show that the estimate in the paper, of 2s., based on entirely different grounds, was correct, although, in fact, all arguments dependent upon the intrinsic value of "tokens" were obviously beside the mark, tokens being *rei naturâ*, and, essentially, coins of less metallic than current worth; and he observed that it was most remarkable that Mr. Hendriks' first objection should be grounded upon what he considered a deficiency of intrinsic value in the rupees, when his very next objection quarrelled with his (Col. Smith's) constituting them as too expensive tokens. He did not think it necessary to trouble the Society with any further reply to this second objection, beyond pointing out that Mr. Hendriks himself had stated that, according to the proposal contained in his paper, the ratio of the rupees, as "tokens," to gold, would be very nearly identical with that in England, Italy, France, and Belgium. He stated that Mr. Hendriks' third objection, namely, that the plan would introduce an imperfect "double standard" into India, for an indefinite time, was founded upon a misconception. He well knew that Mr. Hendriks was far too well informed to make the mistake very frequently made by many others—that of confounding the currency with the standard; and he felt sure that, had he not been writing in haste, he would not have forgotten that it was the marked peculiarity of his proposal that the change was to be effected without the employment of a double standard for a single day.‡ He added that the remainder of Mr. Hendriks' observations, which were mainly addressed to the defence of his own scheme of 1876, and comparisons of it with the plan recommended in the paper, to the disparagement of the latter, he did not feel any desire to criticise or find fault with; but there were one or two phrases which ought not to be allowed to pass unexplained. In the early part of his address Mr. Hendriks spoke of the proposed plan as intended to increase the value of the rupee by its being "levelled up" to 2s., but this, he pointed out, was a mistake; the essence of the scheme, as explained in paragraphs 35, 39, 108, and 109, being that the rupees at present possess a current value of 2s. each, and that the great object of the measures is to prevent their being lowered in value by the currency becoming flooded with cheap silver; and to introduce gold when it can be easily done at 10 rupees for the sovereign. In the latter part of his address, Mr. Hendriks spoke of the serious and arbitrary interference of the Government of India with the natural course of trade, and a little further on, of the influence of the pressure of the Government itself in forcing up the price of its existing standard of value. He would answer these two objections by saying, in regard to the first, that there would be no alteration in the natural course of trade. As explained in paragraph 115 of the paper, the only change would be that merchants and banks having occasion to procure the Indian currency, instead of doing so partly by purchasing silver bullion and sending it out to India for coinage, and partly by purchasing bills, would in future procure it by the latter

* Vide resolution of the Government of India on a Gold Currency. Ordered by the House of Commons to be printed, 28th Feb. 1865, p. 124.

‡ Vide § 546.

means only. In regard to the second objection, he would observe that there certainly would be interference with the exchange, the grand object of the plan being to remedy and fix the exchange; a result which could not be arrived at without interference. But, if the improvement were effected gradually, and with public notice beforeband, it could injure no interests; a fact which, added to a readiness to compensate any possible real grievance, was, he considered quite sufficient to deprive the process of offering bills in the open market for sale at a fixed price to all comers, of the stigma of forcing up the standard of value by the influence of the Government. In truth, as just explained, the standard is already up, and the great object of the measure is to prevent its being lowered. He said he would make no further comments upon Mr. Hendriks' elaborate statements. His papers were always valuable, from the many interesting facts they contained; and he trusted that now that the discrepancy in their figures was cleared up, it would not be very long before he would have the great advantage of his support in regard to this, as he had been privileged on former occasions. He was rejoiced to find that he had Mr. Hendriks full concurrence in the belief that the large supply of gold already in India, and the amount of gold which annually flows to that country in the course of trade, would abundantly supply a gold coinage for India, without creating any disturbance of the natural distribution of the precious metals throughout the world. He said that with regard to the observations of Mr. Foggo, it was quite true that Mr. James Wilson did record objections to a gold currency for India; but it is also true that he at the same time recorded opinions in its favour. He said, in the minute referred to by Mr. Foggo, that if we had to begin *de novo*, the most convenient of all the systems now in practice would be that used in England, where gold is the standard and gold coin the general money in circulation, and silver tokens of limited tender the subordinate coins. He said that Mr. Wilson, being at the time of writing this minute in the act of proposing a paper currency, and very full of his scheme, all his arguments were directed to prove that a paper currency was the best thing for the natives, and he cleared the way for its acceptance by showing that a gold coinage, which he admitted would be most convenient, was impracticable. But although Mr. Wilson used all his arguments in favour of introducing a paper currency, be made use of the expression that he knew of no conceivable method by which gold could be introduced without a double standard; and although he disapproved of a double standard on general economic grounds, still, if gold was to be introduced, it must be by a double standard. He said that on this ground be thought that if Mr. Wilson had lived to the present time, and had known that we have now, by the accident of the depreciation of silver, an opportunity of introducing gold without the slightest difficulty or expense, he must have seen his way to the proposal made in the paper. He must have been quite aware that a gold currency, which the Financial Ministers after him had for 15 years been pressing on the Government of India, and which they, on one occasion, attempted to establish, was very desirable; and if he had had the means of establishing it which we now have, without loss to any one, he would have hastened to introduce it. He could not have declared its use impracticable, or repeated the flimsy and erroneous argument about a breach of faith; and he would doubtless have proposed its adoption, as the proper intermediary between silver and notes, and by far the best medium for settling international balances of trade. He added, that in the 21st paragraph of the paper to which Mr. Foggo referred, Mr. Wilson is only mentioned as having recorded an opinion as to the importance of the introduction of gold, which he does in the 3rd and 23rd paragraphs of his minute. It was not stated, or intended to be implied that he, or any other statesman, proposed any practicable method for its adoption, till Sir Charles Trevelyan proposed the introduction of the British sovereign as a legal tender for ten rupees, with the result stated in the 22nd paragraph of the paper. He said that, in regard to Mr. Dutt's remark that the 160 millions sterling of gold now in India would not be available for coinage, he thought that if he had read the quotation from the pamphlet of Colonel Ballard, who was on the spot, and intimately connected with all the particulars in the case, he would have seen that he said "I especially do not refer to gold ornaments, but to gold coins and bullion kept in reserve," irrespective of which there is a large mass of hoarded gold which, if it were not deprived of legal recognition, would be at all times ready to be poured into the mints to the great assistance of trade. He was of the same opinion as Colonel Ballard, and could not help thinking it was an incalculable injury to the natives to deny them the assistance of the mints, and legal sanction to put their gold into a readily saleable form, without loss, in times of critical emergency. He said, in reply to the question of the Chairman, that when a gold standard is established in India the currency will be exactly in the same position with regard to China, and all silver standard countries, as England is; neither worse nor better. As regards the trade with England, India would be immensely benefited by having the same standard; and her trade with England and Europe is 80 or 90 millions, while that with China is only 15 millions. The establishment of a gold standard in India, and keeping up the value of the rupee, while silver had fallen in China, would turn the exchange with that country very much in favour of India. The Indian rupee would have retained its value, while the Chinese tael would have lost about 12 per cent., so that there would be more Chinese taels than before given to pay for the rupees. He said that in a large measure like the one proposed we should consider not only the immediate trade, but the trade of future years. In this view it must be remembered that China is not the only country in the East. There is Australasia, 50 times as large as England and Wales, and Japan, four times as large, having a gold standard and currency, not to mention other regions. With these countries, as with England, immense advantage would be derived by India having the same standard; and even in her trade with China it must be remembered that a very large portion of that trade is adjusted in London, and would derive the same advantage, while, as regards the rest of the trade, the fact of the exchange turning in favour of India could not do her any harm. In answer to the question as to what commodity China could substitute for the silver she now sends to India, Colonel Smith said that China might still continue to send silver, as the Indian Government would have to replenish the currency. The proposal is that the Secretary of State should sell bills, and that all the money he does not require for home expenses should be sent out in silver to India. He said, in regard to the silver remittances occasionally made from China to India, that to whatever extent those remittances have hitherto been sent direct from China to India, to that extent they diminished remittances from England. The Secretary of State will have to remit silver bullion for coinage, corresponding with the excess of bills he sells over and above his home expenses. If China remitted silver direct to India, that would cause a smaller amount of bullion to be sent from London. The Government of India would buy the silver bullion sent direct from China at the market price. Or, instead of this, the Chinese might send their silver to London, sell it there, and purchase the Secretary of State's Council bills. These remarks constituted the best answer he could give to the question on the spur of the moment. He added that he could not conclude without expressing his extreme personal regret and disappointment that, notwithstanding years of persevering effort, he had failed

to bring about any official inquiry into this important subject. It is, no doubt, one of very considerable difficulty and complication; but he thought that, unless it were taken for granted at the outset that nothing can possibly be done, the very fact of its extreme difficulty, and the innumerable conflicting ideas regarding it, constitute the strongest possible argument for its thorough and searching investigation. He said that at the present moment the estimated public loss by the exchange amounts, in round numbers, to £60,000 a week; and, after two years' incessant discussion, and after hearing all that had been urged on the present occasion, he must still insist with the most absolute confidence, though without the least disrespect for the opinions of others, that this loss may be entirely and for ever put an end to, without the slightest expense or injury to any one, but, on the contrary, with the greatest permanent benefit to commerce and the empire. He said that what he most earnestly prayed for was a full, determined, and searching inquiry, for the purpose of ascertaining the real importance of the advantages and of the supposed objections to the measure, and he would invite attention to the fact, that, if the Secretary of State were to secure the assistance of three of the very ablest men in Europe, and present each of them with £10,000, as a fee for his labour, the expense incurred would be only equal to one-half of the savings of a single week, now being irretrievably sacrificed. Thanking the assembly for the kind attention and patience with which they had listened to him, he said he would now leave the matter in their hands.

The Chairman said it was impossible for him to say at this late hour more than the fewest words possible on the subject. Col. Smith's plan appeared to him to have the great merit of being complete in itself and practical, and it certainly paved the way for the introduction of a gold standard into India, which every speaker present, and everyone he was acquainted with, considered to be most desirable. It was most detrimental to the interests of the State, and the individuals connected with India, that these violent fluctuations in the value of silver should take place. The matter did deserve the most serious consideration at the hands of the able, earnest men entrusted with the care of directing the policy and promoting the interests of India, but he thought statesmen might well be excused if they hesitated long before they ventured to try an experiment of such great magnitude. Still if, as he believed, there was sound wisdom in Col. Smith's scheme, it would gradually, although more slowly than he desired, make its way amongst thinking men, and would be finally adopted. At any rate, whatever might be the effect of his scheme, they were all much indebted to him for the deep study he had given to the subject, for the trouble he had taken to bring it forward, and for the light he had thrown upon it, and he would, therefore, propose a hearty vote of thanks to him for his most able paper.

The motion was unanimously carried.

Lord Borthwick writes as follows:—In acknowledging the Council's invitation to be present to-morrow evening on the occasion of Colonel Smith's paper being read on the "Depreciation of Silver, &c.," I regret my engagements will not admit of my being present, especially as I venture, after a perusal of Colonel Smith's paper, to dissent from many of his views, more especially those expressed on the "true basis of value in a currency."

I regard the origin, volume, and functions of a currency as flowing from causes more simple and less liable to controversy than those advanced by Colonel Smith. Concerning the main subject of Colonel Smith's essay, viz., "The Depreciation of Silver, and Suggested Remedies," after having studied Mr. E. Seyd's, and M. Cernuschi's exhaustive treatises thereon, and had the benefit of several discussions with these gentlemen, Colonel Smith appears to me to complicate the real cause of the existing difficulty and distress unnecessarily, and to suggest remedies inapplicable to the complaint.

It seems to be in vain to look for even a palliative for the existing difficulty about India or other countries trading with us, who take gold as our sole measure while they will take silver short of England (and all other countries who coin a statutory legal tender), adopting a statutory fixed ratio between the two metals; *e.g.*, so long as France, say, was known to be ready to coin gold and silver indifferently, in the ratio of 1 to $15\frac{1}{2}$, this, in a manner, kept the value of silver in all markets at about that price. In England, for example, where an ounce of gold passed for £3 17s. $10\frac{1}{2}$d., *i.e.* $934\frac{1}{2}$d., the price of silver ranged at about 60d. $(\frac{934\cdot5}{15\cdot5})$ (60d. $\frac{3}{10}$), 5s. But when France, for reasons obvious to herself, ceased to coin silver indefinitely, silver, in practice as well as in theory, came under the ordinary laws of prices, and has fluctuated since, as expressed in gold legal tender, like any other commodity, according to market supply and demand. With this reality before us, I fail to see, in the absence of any fixed ratio, conventional or otherwise, how the ounce, or other given weight of silver (in which, in effect, Indian remittances fall to be reckoned), can ever obtain more than its price in gold in any country where gold is the monometallic medium of a legal tender. The price to-day is, say, 54d. or $17\frac{3}{10}$ to 1 of gold $(\frac{934\cdot5}{54} = 17\cdot3)$.

Mr. Seyd, M. Cernuschi, and other learned men, are, I fear, too elaborate and scientific for the general reader; and I, without venturing to take up their clear and exhaustive arguments, have been trying on more than one occasion to give, in a simple way, a few leading facts and inferences.

EIGHTEENTH ORDINARY MEETING.

Wednesday, April 10th, 1878; Captain DOUGLAS GALTON, C.B., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Addy, John, Peterborough.
Brown, Charles Henry, 30, Alexandra-road, Southport, Lancashire.
Hertslet, George Thomas, Lord Chamberlain's-office, St. James's Palace, S.W.
Hirst, William Henry, 125, Mottram-road, Stalybridge.
Hudson, Colonel, Army Clothing Department, Pimlico, S.W.
Merton, Emile R., 161A, Piccadilly, W.
Ramsden, Sir James, Barrow-in-Furness, Lancashire.
Sykes, Thomas H., Cringle-house, Cheadle, near Manchester.
Wilkinson, M. A. Eason, M.D., F.R.C.P., Greenheys, Manchester.

The following candidates were balloted for and duly elected members of the Society:—

Attlee, Henry, Westcott, Putney.
Chater, George, Jun., 68, Cannon-street West, E.C.
Hehner, Otto, F.C.S., 54, Holborn-viaduct, E.C.
Kyd, Hayes, Wadebridge, Cornwall.
Sawyer, John Robert Mather, Brownlow-house, Ealing Dene, W.
Wright, Caleb, Lower-oak, Tyldesley.

The paper read was—

A NEW METHOD FOR PRODUCING CHEAP HEATING GAS FOR DOMESTIC AND MANUFACTURING PURPOSES.

By S. W. Davies, A.R.S.M.

It will be within the memory of many members of this Society that, in the year 1872, a sum of money was placed at the disposal of the Council of the Society of Arts, for promoting, by prizes or otherwise, economy in the use of fuel for domestic purposes.

A committee was formed, to whom was entrusted the task of deciding on the best means for carrying into effect the wishes of the donor. A number of prizes and medals were offered for the best and most economical apparatus for cooking and heating, both by coal and gas. After a careful investigation of the claims of a large number of exhibitors, who forwarded their apparatus for trial in buildings especially erected for the purpose at South Kensington, the committee decided that no prize could be awarded. But, although it was found that inventors had made little advance in the direction of economy of fuel worthy of the name, no doubt minds were set to work to try and fulfil the conditions under which the prize had been offered. Among the various inventions which made their appearance after the conclusion of the Society of Arts experiments, was one by Mr. Joshua Kidd, the principle of which was that the gases from ignited coal were mixed with the hydrogen from decomposed water.

The complete gasification of the fuel used was a remarkable feature of the process, and it was this fact which led some gentlemen interested in the subject to adopt the idea, and to purchase Mr. Kidd's patent. Two years of patient trial, analysis, and experiment have enabled them to alter and adapt the principle contained in the original invention. Difficulties of all sorts have been overcome, and, although they are still on the way to improvement of the gas and its application in many directions, both for heating and lighting, they consider that, in its present state, it is of too great public importance, where a cheap heating gas is required, to delay any longer making its manufacture an application as widely known as possible.

Numerous attempts have been made by previous workers in this direction to produce a cheap gas for heating purposes, by the action of water vapour on incandescent carbon.

It has long been known that if steam be passed over coke or charcoal heated to redness, a decomposition of the steam takes place, hydrogen (H), carbonic oxide (CO) carbonic anhydride (CO_2) and a small proportion of marsh gas (CH_4) being produced.

The composition per cent. by volume of the mixed gas produced in this way is, according to Langlois' analysis—

$H = 54{\cdot}52 \quad CO = 31{\cdot}86 \quad CO_2 = 12 \quad CH_4 = 1{\cdot}62.$

According to Frankland's—

$H = 56{\cdot}9 \quad CO = 29{\cdot}3 \quad CO_2 = 13{\cdot}8.$

It is evident, therefore, from these analyses, that we have here a very important heating gas, could we succeed in producing it in considerable quantities economically. How to do this most effectually has formed the subject-matter of numerous patents. It is not my intention to enter into a discussion on the relative merits and demerits of the various processes proposed in these patents, any such course indeed being rendered unnecessary by the fact that very few of them have been commercially a success. The cause of this want of success is not, I think, far to seek; the apparatus devised for carrying out the process being for the most part large and costly, and rarely complete in itself, or what one may term self-contained—that is to say, in addition to the actual retort or generator in which the gas is produced, a special boiler and super-heater are required for generating and super-heating the steam used in the process, and in most cases the retort or generator requires to be set in a furnace and heated by a special fire, in the same way as an ordinary gas retort. Or, if this course be not adopted, and only one fire used, viz., that in the generator itself, then a special blowing apparatus becomes necessary, and the production of gas is intermittent instead of continuous, for steam and air have to be urged in succession through the same column of fuel, and it is only when the steam jet is in action that gas is produced, the air blast being employed to blow up and revive the fire, the temperature of which is much reduced by the passage and decomposition of the steam.

I think it must be abundantly clear that these extra pieces of machinery and additional processes add very materially to the cost of erecting and working the apparatus, and also to the price of the gas produced, which, taken in connection with the large space occupied by the complete apparatus, entirely prevents it from coming into general use for small manufacturing and domestic purposes, thus shutting it out from what I conceive to be one of its widest and most important applications.

The apparatus I am about to describe and explain, does not, it will be seen, labour under any of the disadvantages enumerated above; it is small, compact, by no means costly, and combines a gas generator, boiler, and superheater in one; it generates its own blast, is continuous in its action, and so easily worked that a person of average intelligence may be taught to attend to it in a few hours.

The generator consists of a hollow cylindrical body or case, made for convenience, at present, of wrought or cast-iron, but which ultimately may be constructed of other materials. This cylinder is terminated below by a cast-iron bottom, having a hole in its centre about one-half or one-third its own diameter; below this again, and forming part of the bottom casting, is a second hollow cylinder of the same internal diameter as the hole above it; in this lower cylinder the fire-grate is lodged; the blast-pipe opening into it below the fire-grate. The grate fits the cylinder loosely, and is attached to it on one side by means of a hinge, the other side being supported, when in position, by a pin screwed through the cylinder; this arrangement permits the grate to be readily moved up and down, and facilitates the withdrawal of the charge when necessary.

When making gas, the bottom of the small cylinder requires to be closed air-tight. This is effected either by means of a flat hinged plate, which is kept tightly pressed against it by a heavily weighted lever, or else by a short cap with a

bevelled edge attached to it by a bayonet joint. In the upper and larger cylinder there is a coil of thick wrought iron pipe, which fits the cylinder pretty closely, and is attached to it by means of a series of brackets or supports, which prevent the coil from collapsing by its own weight. At the bottom the coil is protected from the intense heat of the fire by a thin lining of gannister. The two ends of the coil are turned outwards at right angles, and pass gas-tight through the body of the generator: the lower end is connected with an arrangement for supplying water under pressure, and the upper end with a steam pipe of smaller diameter, which passes down parallel to the generator, and terminates in a small steam tap immediately in front of the blast-pipe.

The top of the apparatus is a casting of rather peculiar shape. In its centre there is a circular opening about nine inches in diameter, communicating below with a hollow inverted truncated cone projecting into the interior of the generator. At the apex of the cone there is a narrow cylindrical ring, which serves as the seat for a heavy conical valve, which fits it gas-tight. Above, this is surmounted by a short cylindrical fuel box, carrying at its upper end a hopper, the opening between them being covered by an ordinary flat sliding plate or valve. Attached to the fuel box there is a short flue, used when lighting the fire, but closed when making gas. In addition to the central opening in the cover of the apparatus, there are two smaller ones; the larger of these being the gas outlet, and the smaller a peep or stoke-hole; this is closed, when not in use, by a gas-tight cap or plug. The whole apparatus is supported on three legs, attached to the flat underside of the bottom casting.

Presuming I have succeeded in making the construction of the gas-producer intelligible, it will, I think, be readily seen that, if a fire be lighted in the interior, and water driven through the coil, that water will be rapidly caused to boil, steam will be produced, which will accumulate in the upper part of the coil, and, if not immediately allowed to escape, will take up a further increment of heat, and pass into the condition of superheated steam. If now the tap in front of the blast-pipe be opened, this superheated steam will pass down the small pipe outside the generator, and blow with considerable force into the blast-pipe, carrying with it, by its inductive action, a stream of air. By properly apportioning the size of the steam jet to the internal diameter of the coil, a constant supply of superheated steam is obtained, and, as a matter of course, a continuous blast of air ensured. In this way, then, the requisite oxygen to support combustion, and steam for decomposition, are driven into the apparatus with considerable force, from which, after traversing the column of heated fuel, they issue as a permanent gas.

Before, however, tracing the mixture in its upward course through the fire, it will, perhaps, be as well to describe the mode of working the apparatus, in order that you may see how very simple the operation really is. For this purpose, I will assume that the generator is empty.

Before lighting the fire, I shut the valve in the gas main, open that at the bottom of the ash-box, lift the conical valve off its seat by means of the lever handle outside the fuel-box, close the steam tap, and open the water-cock, so that I start, in fact, with the coil full of water, and the interior of generator in free communication with the chimney. The fire is lighted in the ordinary way, the necessary wood, coal, &c., being charged in through the hopper; a light is applied to it from below the fire grate, and the chimney draught draws up the fire in the same way as in a common closed stove. When the fire burns briskly up, as it generally does in about a quarter of an hour after lighting, unless it be fed too fast or otherwise checked, superheated steam will be abundantly produced. The steam tap may now be slightly opened, the valve at the bottom of the ash-box closed, and the fire more rapidly blown up by the steam blast, the jet being gradually opened as the intensity and body of the fire increases, until the full blast is given. In charging the apparatus with fuel, it is advisable not to use large lumps, nor—especially at first—to feed it too fast, otherwise an injurious lowering of the temperature in the upper part of the generator is likely to take place, and wet instead of superheated steam comes over. By a judicious use of the peep-hole this may entirely be prevented, as new fuel should only be added when the upper part of that already in the generator begins to appear red-hot. The charge of fuel is put in the hopper, and the sliding plate withdrawn; this allows the fuel to fall into the cylindrical box beneath, and if the conical valve be up it passes direct to the generator; if, on the other hand, this valve be down—as is always the case when making gas for use—it falls upon and around the valve, and remains in the fuel box till this valve be lifted, which, of course, should not be done before replacing the sliding-plate between the hopper and the fuel-box. This mode of charging prevents any escape of gas into the room, and admits of the apparatus being fed as often as may be necessary while making gas.

When the generator becomes about one-third to one-half full of fuel, good gas will be abundantly produced, which may be turned at once into the gas main. To do this, it is only necessary to drop the conical valve on its seat, and open the gas outlet, when, the communication with the chimney being cut off, the gas passes directly to the pipes and apparatus connected therewith.

The water is supplied to the coil under pressure. The necessary pressure may easily be obtained in either of two ways—viz., by a cistern placed at a sufficient height above the generator, or by a small accumulator standing alongside it, and provided with a hand force-pump and gauge. The latter plan is much to be preferred, as it enables the pressure to be altered at will, and brings the whole process well under control. For this purpose only a very small accumulator is necessary, and the amount of extra work thus thrown on the attendant is almost nominal. For instance, I have worked a generator producing about 4,000 cubic feet of gas per hour with an accumulator only 2ft. high by 9in. in diameter, and I found, even with so high a pressure as 60lbs. on the square inch, a few strokes of the pump every quarter of an hour or so was all that was required to keep up the pressure and supply the coil with water. The accumulator we employ consists simply of a hollow cylindrical

vessel provided with a force-pump and gauge, and containing air, by the compression of which any desired pressure may be obtained, from 1 or 2lbs. to 100lbs. on the square inch; it acts, therefore, on exactly the same principle as the air-vessel of a pumping-engine.

Here I would call your attention to the absolute safety of this method of working, and to the impossibility of bursting the coil, even should a stoppage occur in it. The only thing that could happen in such a case as this is, that the water and steam in the lower part of the coil would, when the pressure rose high enough, be driven back into the accumulator, where the steam would be instantly condensed in the cold water, which it would barely warm, as the quantity of steam in the coil, compared with the quantity of water in the accumulator, is extremely small. This arrangement, therefore, acts as a most perfect safety valve, and prevents the steam pressure from ever rising sensibly above the ordinary working pressure.

Now, as we have seen, the air blast is set up and maintained by the inductive action of the jet of superheated steam playing into a small tube or blast-pipe, which opens into the cylindrical ash-box beneath the fire-grate. The intensity of this blast, therefore, will manifestly depend upon the water pressure in the accumulator, and as the force with which the gas issues from the generator will clearly be proportional to the strength of the blast, the whole admits of easy adjustment, to meet the varying conditions of pressure and resistance which the gas may have to overcome. With respect to the actual gas-pressure obtainable in this way, I found experimentally that, with a water-pressure in the accumulator of 15 lbs. on the square inch, I obtained a gas-pressure in the generator of over 1 in. of water, and with a water pressure of 40 lbs. on the square inch, the corresponding gas-pressure in the generator was 2½in. of water. This latter is considered to be a good average working pressure.

The fire-bars are kept cool by the steam and air pressing between them, and are thus prevented from rapidly burning or oxidising away.

The chemical reactions which occur in the generator I take to be very simple. Carbonic anhydride (CO_2) is doubtless first formed by the action of the oxygen of the air upon the carbon of the fuel; this in its passage upward through the heated fuel takes up another equivalent of carbon, becoming reduced to carbonic oxide, CO, thus, $CO_2 + C = 2CO$, the nitrogen of course passing off unchanged and serving only to dilute the gas. With respect to the steam, this, as explained above, is decomposed in its passage over the incandescent coal with the formation of hydrogen, carbon-monoxide and carbonic anhydride. The latter in its upward course sharing the same fate as the CO_2 produced by the action of the oxygen of the air, *i.e.*, it takes up another atom of C, and passes into the state of CO. The decomposition, therefore, of the steam adds materially to the calorific value of the gas, by enriching it with hydrogen and a further quantity of CO.

The composition of the gas produced by this generator, when working at different pressures of water, and with various kinds of fuel, has been determined by analysis. The result is as follows:—

Description of fuel.	Pressure of water.	Composition per cent. by volume of the gas.
	Square inch.	
Peat charcoal	15 lbs.	CO = 28·6 H = 14·6 CO_2 = 4·0 N = 53·0 100·2
Anthracite	15 lbs.	CO = 22·6 H = 10·0 CH_4 = 4·9 CO_2 = 4·5 N = 58·0 100·0
Equal parts of anthracite and steam coal	30 lbs.	CO = 28·3 H = 9·3 CH_4 = 5·2 CO_2 = 6·2 N = 51·3 100·3
Anthracite	60 lbs.	CO = 26·4 H = 13·5 CH_4 = 1·4 CO_2 = 3·9 N = 54·8 100·0

As regards the quantity of mixed gases produced from a given quantity of fuel, this has been ascertained experimentally in the most careful manner, every precaution being taken to eliminate all sources of error. The gas from the generator was first passed through about 100 feet of 3-inch pipe, more than 50 ft. of which was out in the open air, and then through a large meter.

Before reaching the meter, therefore, the temperature of the gas had been reduced to about 60° or 70° Fahr.

The following are the results:—

Description of fuel.	Water pressure in lbs. per sq. in.	Cubic ft. of gas per lb. of fuel.
1. Anthracite	15	69·5
2. Equal parts of anthracite and steam coal	20	85·2
3. Equal parts of anthracite and steam coal	25	88·84
4. Equal parts of anthracite and steam coal	30	94·5
5. Anthracite	40	(over) 100·0

It will be seen, therefore, that there is a steady increase in the quantity of gas produced per lb. of fuel consumed, as the water pressure rises from from 15 lbs. to 40 lbs. Beyond this point there does not appear to be much advantage gained by still further increasing the pressure, at least this is the case in the smaller size generators, with which hitherto most of the experiments have been made. I confess it is somewhat difficult to account for the increased yield of gas at the higher pressures, as of course no one pretends to be able

to obtain more than a certain definite quantity of carbonic oxide and carbonic anhydride by the oxidation of a given quantity of carbon. I think, however, it may be due in part to two causes. At the higher water pressures the force of the steam jet is proportionally increased, consequently a larger volume of steam and air is injected into the apparatus in a given time. This gives rise to more intense combustion of the fuel, which is, I believe, at the same time more perfect combustion, and it is to this cause and the fact that a larger volume of steam is simultaneously decomposed, that we must attribute the increased yield of gas.

After making numerous trials of different kinds of fuel, the conclusion arrived at, is that although a variety of non-caking fuels, such as coke, wood-charcoal, peat-charcoal, steam coal, &c., may be used, yet, on the whole, anthracite coal gives the best results, and is much to be preferred for use with the apparatus.

It might be thought that tying it down in this way, to the use of one particular class of fuel, would very much tend to restrict the use of the apparatus, and practically shut it out from competition for steam boiler purposes, especially on board ship. I do not, however, think this will prove to be the case. We have vast stores of anthracite coal both in Wales and Ireland, at present almost unworked, and waiting to be developed, only a very small quantity being now raised for copper smelting, and a few minor purposes. So also in British Columbia, Vancouver's Island, and many other of our insular possessions, there are great quantities of this fuel lying practically useless, because as yet no practicable method of burning it economically in our ordinary furnaces has been discovered; indeed it has been stated that at some of these places we have been obliged to establish coaling stations, and carry to them ordinary bituminous coal for the use of our steam ships, because our boiler furnaces are not adapted to burn the fuel already on the ground.

The use of what has been termed anthracite coke in marine boilers was advocated in a paper read last summer before the United Service Institution, by Captain Geary, R.A., in which he states that, by the use of this kind of fuel, burnt under blast in a specially constructed furnace, quite separate and distinct from the ordinary boiler furnace, or in what is practically a gas generator, somewhat resembling the one I have described, he got a result which was superior as regards fuel consumed, and the speed of producing a certain effect, to a similar boiler fired in the ordinary way, in the proportion of 6·8 to 1.

In the discussion which followed the reading of this paper, the desirability of devising some means of utilising anthracite for steam navigation purposes was insisted on by nearly every speaker, and the subject still excites considerable attention among naval architects and engineers.

I venture, therefore, to think that this apparatus is a step in the right direction.

Of all the proposed methods for generating a cheap heating gas, either for domestic or manufacturing purposes, the only one, so far as I know, that has hitherto met with much success, is the process patented by Siemens. This is now extensively used in the manufacture of iron, steel, glass, &c., both in this and other countries. It will perhaps be worth while, therefore, to institute a comparison between the quantity and quality of gas produced by this process and the one I am describing.

In Percy's "Metallurgy," vol. i., p. 528, the composition per cent. by volume of the gas produced by a set of Siemens' generators in work at St. Gobain, France, is set down as:—

Hydrogen	=	4	to	11	per cent.
Carbonic oxide	,,	15	,,	19	,,
Carbonic acid	,,	6	,,	7	,,
Nitrogen	,,	75	,,	63	,,

The first two of these constituents, or from 19 to 30 per cent., are alone of any use as fuel.

Turning now to the analysis of our gas given above, I find that the inflammable constituents stand in the proportion of from 37·5 to 43·2 per cent. The gas produced by this method, therefore, is much richer in heat-producing material than the gas produced by Siemens' method, and of course, its calorific value is proportionally increased.

With regard to the respective quantities of gas produced by a given consumption of fuel in the two processes, I find Dr. Percy estimates that one ton of coal exclusive of earthy matter or ash is capable, when treated in the Siemens generator, of producing about 50,000 cubic feet of gas at 15° C.

The records of the experiments made with this apparatus, and of which I gave a brief epitome above, show that one ton of fuel treated in it, yields from 155,680 to 224,000 cubic feet of gas; that is, from 3 to 4½ times the quantity yielded by the Siemens process. This gas, therefore, is both richer in quality, and produced in much larger quantity than Siemens; a fact which, if it stood alone, ought to be sufficient to prove the great practical value of the invention.

There is, however, one other point to which I would for a moment direct attention. Siemens' generators are large and costly, and the space occupied by the complete apparatus is very considerable; they are therefore only applicable to large manufacturing and metallurgical processes, such as those enumerated above, and are in nowise adapted for making gas for smaller works or private establishments.

On the other hand, these generators can be made almost of any size, either small or large, so that they are eminently adapted for use in small manufactories, such as chemical works, potteries, foundries, forges, drying processes, &c., where cleanliness, economy of fuel, absence of smoke, and simple regulation of temperature are required. Further, it is believed that the comparatively small cost of the apparatus, and the ease and facility with which it is put into operation, renders it peculiarly fitted for making gas for domestic purposes. The use of gas as fuel is beginning now to be more generally understood and appreciated, and it is pretty readily admitted that, for cooking purposes at least, it is nearly as economical to employ gas as coal, with the advantage that it is much cleaner—there is no dirt, dust, or soot—and the saving in labour alone is very great. In addition, it has been clearly shown that the waste of meat when cooked by gas is from 10 to 15 per cent. less than when cooked in the ordinary way. At the

London Hospital it has been estimated that a saving of £400 a year has been effected by substituting cooking by gas for cooking by coal; and a large employer of labour, on whose premises the cooking is done daily for about 1,200 people, states that he is saving something like £800 a year in a similar way.

Of course, at both these establishments ordinary street lighting gas is the fuel employed, and the burner used is that invented by Bunsen, and generally known by his name. The peculiarity of this burner consists in mixing air with the gas before it is consumed. Under these circumstances the gas burns with a blue, lightless flame, and there is no deposition of soot or carbonaceous matter; the gas is, in fact, perfectly burnt, the sole products of combustion being water and carbonic anhydride, or, as it is more generally termed, carbonic acid.

The gas produced by these generators is essentially a non-luminous gas. When taken direct from the producer, it burns with a reddish blue flame. After having, however, been stored in a gas-holder for a few hours in contact with water, the flame loses this red tinge, and the gas burns with a blue lightless flame very much resembling ordinary gas burnt in the Bunsen burner. In neither case is there any smoke, soot, or deposit of any kind by the burning gas, the sole products of combustion being water and carbonic anhydride. It is unnecessary, therefore, to mix air with this gas before it is burnt, as there is no luminosity to be destroyed, or deposition of carbonaceous matter to be prevented.

On the table there are two gas-burners; one is a Bunsen burner of the ordinary construction, connected by a piece of tubing with the street gas supply; the other is simply a bent tube, somewhat resembling the Bunsen in shape, but having no holes at its base for the admission of air; this burner I will connect by a piece of flexible tube with a small holder in which a quantity of the heating gas has been stored for hours. Both burners are now in action, and you see there is a marked resemblance between the two flames.

Of course, notwithstanding this similarity, there is a considerable difference in the calorific power of the two gases. Very careful trials show that it requires about five times the bulk of this gas, as of ordinary lighting gas, to heat a given quantity of water through a certain number of degrees.

But this comparison only holds good when the two gases are burnt in the open air. The ordinary ring burner, which appears to be tolerably well adapted for use with common lighting gas, is not in any way an advantageous form of burner for our heating gas, but as the manufacture of special means is always an encumbrance to the application of any novelty, I think I am best recommending its use by showing you what our gas can do with the ordinary appliances in use.

We have ample evidence in every direction experimented on, that the greatest development of heating power is obtained when the gas is burned in what may be called "partial confinement," or with the jets so enclosed, that the air entering to support combustion is capable of being easily and accurately adjusted. As, however, this point remains to be more fully worked out, we will not take it at all into account in forming an estimate of the comparative cost of doing a given amount of work by the two kinds of gas, but will assume, as the basis of our calculations, that one cubic foot of coal gas is equivalent in heat-giving power to five cubic feet of the heating gas.

A No. 1 generator will produce on an average 1,000 cubic feet of gas per hour, and consume about 10 lbs. of coal; taking a working day of 10 hours, the consumption of coal will be about 1 cwt., and the gas produced, 10,000 cubic feet.

The cost of the 10,000 cubic feet of gas will be as follows:—

	s.	d.
1 cwt. of anthracite	1	1
Wages of attendant	4	0
Ordinary coal and wood used in lighting the fire	0	2
	5	3

The cost of the 2,000 feet of lighting gas required to do an equivalent amount of work is from 7s. to 8s.

With the larger size generators the saving is still more marked. A No. 2 generator consumes about 35 lbs. of coal an hour, and produces 3,500 cubic feet of gas an hour. The cost of the 35,000 cubic feet of gas produced in a working day of 10 hours, is as follows:—

	s.	d.
$3\frac{1}{4}$ cwt. of anthracite	3	6
Wages of attendant	4	0
Ordinary coal and wood used in lighting the fire	0	4
Total	7	10

In heating power this would be equal to 7,000 cubic feet of ordinary London gas, costing from 24s. 6d. to 28s. It is, therefore, manifest that where the consumption of gas is considerable, a most important saving is effected by using the larger size apparatus.

I think, however, it is only fair to say that when working the No. 1 generator the attendant's time is by no means fully occupied; indeed, in some experiments I made with the apparatus, lasting over several weeks, one man attended to three of them with the greatest ease.

The cost of the application of this gas for large establishments will depend on the rate, and the varying quantity of the consumption; if this be constant and continuous, it is not absolutely necessary to introduce even a pressure regulator between the generator and supply pipes, as the gas can be carried direct to the cooking and heating apparatus and there consumed. The only advantage gained in such a case as this, by the use of a governor, is that the pressure in the main is kept constant while charging the generator with fuel.

If, however, the gas cannot be usefully consumed as fast as it is generated, then it becomes necessary to employ a holder and to store the gas in the ordinary way. For this purpose any common gasometer may be used, no specially constructed holder being required.

The gas can be sent direct from the generator to the holder, without passing it through a scrubber or other apparatus for washing or cleaning it, as there are no tarry or ammoniacal products to be condensed or removed. Also the pressure under which it is produced is sufficient to overcome a resistance measured by a column of water two

inches in height, and this, in a common gas-holder, is amply sufficient for most purposes; no adjustment of the weights, therefore, every time the holder is filled, becomes necessary.

At the works in Battersea, the gasometer is generally kept weighted, so as to give a pressure in the mains of about one and a half inches to two inches of water. Not the slightest difficulty is experienced in working the apparatus against this amount of resistance, with a water pressure, in the accumulator of 40 lbs. on the square inch.

I have often been asked whether this gas does not become deteriorated by being stored in contact with water. Some people seem to labour under the misapprehension that, because it is produced in part by the decomposition of water vapour, there is a corresponding tendency towards condensation; they appear to forget that the constituents of the water have been separated by the action of the incandescent fuel, and transformed from a readily condensible, completely—or at least permanently—oxidised gas, or vapour, into two gases, which at ordinary temperatures and pressures are non-condensible, but slightly soluble in water, and only one of which is partly oxidised.

To prove, however, that the gas suffers no material change in composition by being stored in contact with water, an analysis was made of a sample that had been kept in the gasholder for more than a week. This gas contained is 100 parts, as follows:—

Carbonic oxide	CO	=	24·3
Hydrogen	H	=	15·5
Carbonic anhydride	CO_2	=	3·4
Nitrogen..............	N	=	56·8
		Total	100·0

On comparing this analysis with those of the unstored gas given above, it is manifest that no bad effect is produced on the gas by storage, and that it may be kept for any reasonable time in a holder without deterioration. This, therefore, disposes of the question of the storage of the gas in holders, &c.

I mentioned, however, just now, that in large establishments—such as clubs, hotels, hospitals, barracks, unions, prisons, &c.—in which the consumption of gas for cooking and heating purposes would of necessity be large, no holder is required, as the gas can be used direct from the generator. This has been practically demonstrated in the most complete manner at the works of Messrs. Leoni and Co., gas stove and range makers, New North-road, N. At these works a long series of trials were carried out with the apparatus, and in every case the gas was passed direct from the generator into the 4-inch main, with which the various cooking and heating stoves to be experimented on directly communicated. No pressure-regulator or governor of any kind was employed in these experiments, neither was there any alteration made in the apparatus to adapt it to the use of this gas, except the stopping up of the air-holes in the atmospheric burners.

In one trial two large ovens, each 5 ft. high by 2 ft. 3 in. wide, by 2 ft. 6 in. deep, a boiler holding 35 gallons of water, and a large steamer, were joined up to the 4 in. main. At first the whole of the gas produced was turned into the ovens and boiler; in 75 minutes after lighting the gas, the ovens reached a temperature of 400° F., and in 15 minutes more the water in the boiler was at the boiling point. The gas under the boiler was then nearly turned off, that in the ovens being slightly lowered, and the steamer got to work; in 30 minutes after lighting there was an abundance of steam for cooking purposes. This steamer is calculated to cook 1 cwt. of potatoes in about 30 minutes. All this time the ovens were kept at a temperature of 400° F.

The actual quantity of ordinary gas required to work the ovens and boiler, or ovens and steamer, is from 280 to 320 cubic feet an hour. Estimating the quantity of gas produced by the generator at 1,200 cubic feet an hour (which is its outside rate of production), it will be seen that the comparative heating effect of the gas, as determined by these trials, is considerably higher than that assumed when making the calculations given above. Since this trial was made Messrs. Leoni have tested the apparatus in all sorts of ways, and in every case with pretty much the same result. Not the slightest difficulty has ever been experienced in using the freshly prepared gas direct from the producer, without the intervention of a gas-holder or pressure regulator of any kind. This is justly looked upon as a very important point, especially as regards the application of the gas in large towns, where gas-holders would be often inadmissible, and the introduction of pressure regulators even, might, in some cases be attended by considerable inconvenience. We are now, however, in a position to state positively that such adjuncts can, in the case of large establishments, be entirely dispensed with, and that the gas may, for cooking and heating purposes, be directly applied.

Experiments of a somewhat similar kind to those detailed above were made on soldiers' cooking apparatus at Wellington Barracks. As, however, the results were in both cases almost identical, it will be unnecessary for me to enter into a long description of them. I will therefore confine myself to one experiment. In one of the cook houses there is a large Dean's roasting and baking oven—internal measurement, 4 feet × 2 feet × 2 feet = 16 cubic feet content. To this oven it was decided to apply the gas. For this purpose it became necessary to devise a special burner, as the oven is arranged for burning solid fuel. The burner employed was made in the form of a cross, each arm having in its upper side a circular opening two inches in diameter for the exit of the gas. This was placed in the fire-place, and connected with the generator by a three-inch main, and the whole of the gas produced by a No. 1 generator burnt in it. The flame from the burning gas did not impinge directly on the flat iron bottom of the oven, but upon the invert of a flat arch of fire-brick four inches thick closely applied to it, and forming the crown of the furnace. This arch and brick lining of the fire-place were raised to a bright red heat in about 45 minutes after lighting the gas. The temperatures attained by the oven were as follows:—

30	minutes after	lighting,	temperature,	235° F.
45	„	„	„	336° F.
60	„	„	„	450° F.
75	„	„	„	523° F.

Before making this trial, the oven had been lying neglected for some months, as it was considered

by the cooks to be a particularly badly constructed one, in which, on account of the sluggish draught, they were unable to either bake or roast properly. They were not, it is true, very sanguine of our being able to do with gas what they had failed to accomplish with solid fuel, and were at first rather inclined to shake their heads and smile incredulously. The result, therefore, took them completely by surprise. They have a rough and ready method of ascertaining approximately the temperature of the interior of their ovens by touching the iron nobs on the doors. Just before the close of the trial they came one after the other and applied this test—which to them was a much more satisfactory one than the indications of a thermometer—and they declared that if they had fired the oven in the ordinary way for a whole day it would not have been so hot. Even with the best constructed ovens it takes them from two to two and a half hours to get up the same heat that we reached in little over an hour, and that, too, with a much greater consumption of fuel. Thus, the No. 1 generator used in this trial consumes from 10 to 12 lbs. of coal an hour. Their furnaces, as near as one could ascertain, burn from 15 to 18 lbs. of coal an hour; consequently we did with from 12 to 15 lbs. of coal in 75 minutes, what it takes them 120 to 130 minutes to do with from 30 to 40 lbs. of coal.

The most eminent metallurgists and engineers have long maintained that the most perfect kind of fuel, for either manufacturing or engineering purposes, is gas. It will be quite useless, therefore, for me to stop to insist upon this point, or do more than just indicate some of the advantages that have been claimed for this kind of fuel. Briefly, these are as follows:—

1. Saving of fuel, less being required to do a given amount of work.
2. Increase of work done in a furnace of given dimensions, being the result of the great calorific power at command.
3. Complete command over the heat of the furnace.
4. Perfect uniformity of heat throughout the furnace, and greater durability of brickwork, owing to the absence of ashes, by which the fusibility of the surfaces with which they come in contact is much increased.
5. The production of a flame of such purity as to diminish materially the waste by oxidation and deterioration of the metals, &c., operated on.
6. Increased command of the heat employed, and of the chemical effects produced by the flame, which can be immediately checked when required, or at once changed from an oxidising to a reducing one, or *vice-versa.*
7. Great cleanliness.
8. Absence of smoke and soot, which, in the neighbourhood of large towns, is of great importance.

These admirable qualities have led to the adoption of this kind of fuel in a number of works, and for a variety of purposes. The great bar that has hitherto prevented it from being much more extensively used is, as before-mentioned, the cost and size of the generator and its appendages. It is, however, believed that now a simple means has been discovered of producing a richer heating gas than that hitherto employed, and in any quantity at pleasure, either large or small, to suit the special purposes for which it is required, that its well-known and manifold advantages will ultimately result in its being almost universally adopted in small as well as large works to the exclusion of the grosser forms of fuel; and that it is only necessary to make the existence of this apparatus more widely known to insure a steady and increasing demand for it.

A series of experiments have been made, with the view of showing the applicability of this gas to the heating of furnaces for metallurgical and other processes. Of course, no experiments were needed to prove that in a properly-constructed furnace a very high temperature could be obtained by the use of gaseous fuel, as that point has long been set at rest by Siemens and others. But it was necessary to show to intended consumers that our gas could be utilised in this way, and that in a furnace of corresponding dimensions as high a temperature could be attained by the consumption of the gas produced by this small generator—burning on an average 10 lbs. of fuel an hour—as by a large apparatus consuming from two to three tons of coal a day, and that, too—if possible—without the use of those large, brick, regenerative chambers, which are so costly an adjunct to the larger apparatus.

With this view we had constructed a small furnace, to which was applied the gas from a No. 1 generator. I shall not trouble you with the details of this furnace, as it was so obviously defective in many respects that to describe it in its present form would be useless. Suffice it to say, notwithstanding these defects, by means of an extremely simple accumulating and reversing arrangement, a temperature of from 2,000° F. to 3,000° F. was readily attained in it, and cast-iron melted in a few minutes.

This result is so far satisfactory, but it falls very far short of what can, and will be, attained with an improved construction of furnace. On this point, however, further experiments are much needed, in order to put this very important matter beyond the possibility of a doubt; but such experiments, I need hardly point out, require time and means.

As regards the application of the gas for steam boiler purposes, comparatively few experiments have been made, and those only of a very rough description; the results, however, tend to show that, with better modes of applying the gas, and with the experience gained in those trials to guide us, very much better things may be expected from any future trials.

In some experiments made at Woolwich Arsenal on a small boiler in the chemical laboratory, we succeeded in getting a considerably greater evaporative effect, per lb. of fuel consumed, than was obtained when the same boiler was stoked in the ordinary way.

Of course, in making such experiments as these, it has always to be borne in mind that the apparatus under trial must be adapted to the boiler, and not the boiler to the apparatus. This is the principle on which the experiments at the Arsenal were conducted, and I must confess my opinion now is that, in tying ourselves down too rigidly to this rule, we committed a grave error. For it is obvious that it is next to impossible to obtain anything like the full calorific power of gaseous

fuel by attempting to burn it—almost without preparation of any kind—in the large ill-constructed furnaces in which so much solid fuel is now wasted in our boilers.

However, as I said just now, we gained valuable experience from those trials, and the result was far from being an unsatisfactory one, notwithstanding the crude way in which the gas was applied.

If, in future, we should be in a position to undertake fresh experiments in this direction, and a judicious combination of the experience thus gained be effected with another well-known experimental fact, viz., that in a combustion chamber, if the walls be persistently kept far below the temperature at which combination of oxygen and hydrogen, or oxygen and carbon takes place, the resulting combustion must of necessity be imperfect. I have no doubt a far different result will be obtained, and the immense superiority of gaseous over solid fuel, for boiler purposes, be most completely demonstrated.

Respecting the use of the gas for illuminating purposes, I have not much to add. We have seen that, as it comes from the producer, it is essentially a non-luminous gas. Attempts have been made, during the process of manufacture, to convert it into a permanent illuminating gas, by throwing into it the necessary proportion of carbon; as yet, however, these attempts have only been partially successful.

Of course, the gas can be carburetted in the same way as common air, by passing it through a peculiarly constructed vessel termed a carburetter, containining the highly volatile distillate from petroleum known as gasoline. Under these circumstances, it takes up a quantity of the hydro-carbon vapour, and becomes transformed into a luminous gas of considerable power. With the special burner recommended for use with this gas, as high an illuminating power as 19 Parliamentary sperm candles has been obtained, and an average light of from 15 to 16 candles, with a consumption of about 5 cubic feet of the carburetted gas per hour. I have here a small carburetter, containing gasoline, and connected with it is one of the special Argand burners. I will pass some of the gas from this holder through the vessel, and show you the flame of the carburetted gas; and in order that you may form a better estimate of the change effected in the gas by this process, I will again light the simple bent tube burner we employed just now. This, as you see, is connected with the gas-holder direct, and not with the carburetter. Both burners are now in action, and you can judge of the effect produced on the gas by mixing with it the vapour of the volatile hydro-carbon.

It will, perhaps, be as well to state here, that this carburetting process forms no essential part of the principle of the apparatus I have described; it is only looked upon as a useful adjunct in places where coal gas cannot be readily obtained, and it is not intended for one moment to compete with the latter for illuminating purposes.

When it is intended to carburet the gas, and to employ it as a source of light as well as heat, it becomes absolutely necessary to use a gas-holder, both to store the excess of gas made by the generator, and also to equalise the pressure, which in the generator itself is liable to slight fluctuations, of no consequence whatever when the gas is simply used as a source of heat, but highly objectionable when it is employed for lighting also.

DISCUSSION.

Mr. Hale said he had not quite understood the comparative expense of this gas and the ordinary gas, and doubted whether it would be wise to have two sources of gas laid on for domestic purposes.

Mr. Davies said the cost of this gas was about 5s. 3d. for 10,000 ft. in the small generator, but when a larger generator was used 7s. 10d. for 35,000 cubic feet, or about 3d. per 1,000. This was equivalent in heating power to 7,000 ft. of ordinary London gas, costing from 24s. 6d. to 28s. It was not supposed that this apparatus could be introduced into every small household; but it was rather intended for large country establishments, where ordinary gas could not be readily obtained, and also in manufactories and places where a clean fuel, free from dirt, ashes, and sulphurous compounds, was required. In reply to another question, as to whether this gas was explosive, he said that all gases were explosive when mixed with oxygen in certain quantities; but, owing to the large per-centage of nitrogen, this was very little explosive. In fact, he had at times found considerable difficulty in making it explode when mixed with pure oxygen and an electric spark passed through it.

Sir Francis Knowles, Bart., F.R.S., said that some time ago he was kindly allowed by the proprietors of this invention to inspect their works at Battersea, when he was much struck with the extreme cleanliness and simplicity of the invention, but there was one element on which he must offer Mr. Davies his condolence, namely, the large quantity of nitrogen, which must considerably reduce the temperature of combustion, and, therefore, the effective heat of the fuel. If they could succeed in getting rid of that, and he saw no reason why they should not, the temperature would be much increased. He did not know whether Mr. Davies had calculated the temperature of combustion.

Mr. Davies said he had not.

Sir Francis Knowles said that was a most important element. If to boiling water you added an equal quantity of cold water, you would only obtain a heat much below the mean of the two temperatures, and the introduction of this nitrogen, which was inevitable, it appeared, at present, in consequence of the combustion of fuel necessary to vaporise the water, would act in the same way as cold water, and must, of course, very much deteriorate the value of the fuel. This use of water gas was by no means novel, the only novelty being the form of the apparatus. Some years ago the proprietors of large iron works in the North endeavoured to apply this gas in their blast furnace. They collected a large quantity of it in a gas-holder, their idea being that it would save fuel by blowing it through the tuyeres in combination with the ordinary blast. On recently writing to ask the result, the answer was that unfortunately, after they had worked it a short time ago with no particular advantage, owing to the neglect of a little urchin entrusted with an important function in the process, the whole affair disappeared into space, and unfortunately the little urchin disappeared with it. But he had obtained an analysis which very much differed from that now given. Mr. Davies had only given the analysis by volume, and he regretted he had not given it by weight also. The analysis he referred to was as follows:—H 56; CO 29; CO_2 15·80; Light Carb. Hyd. ·3, so that the nitrogen was entirely absent. He did not exactly know the process by which it was manufactured, but it was so arranged as to exclude the nitrogen, and he thought it would be well worth the while of Mr. Davies and his allies to turn their attention to that point,

In other respects it appeared to him a highly useful application—more particularly for domestic uses, for he considered it would be limited to that rather than being applicable on anything like a large scale in manufacturing; because in the comparison with the heating power of fuel it would be found that the heating power was not so great. At the same time he did not at all wish to find fault with the invention, but simply speaking the truth in the interest of science to point out where the imperfections lay. He should like to see a bit of platinum wire placed in the flame to test its heating power.

[This being done, the platinum wire was heated to a bright red.]

Sir Francis Knowles said had it not been for the presence of nitrogen the wire would have been of a dazzling white. At the request of a gentleman in the room, he repeated the analysis above given, and added the analysis by weight; namely, H 10·51; CO 51·59; CO_2 33·26; Light Carb. Hyd. ·63. He would also say that in all these gases which ought properly to be called wet gases—gases containing hydrogen, particularly when burnt with common air, you had a great loss of heat; owing to the generation of aqueous vapour in the products of combustion, the specific heat of aqueous vapour was very high indeed, about ·836, so that, in fact, it robbed you of very nearly all the heat you were generating. There was an enormous quantity also of nitrogen imported in the process of burning this hydrogen. For every pound of hydrogen you burnt you had to introduce eight pounds of oxygen, and for every 23 pounds of oxygen you had to introduce 79 of nitrogen, all of which you had with the aqueous vapour to raise for final temperature of combustion, and when you came to distribute in a sort of quasi-partnership all the heat you had, you were robbed of a great quantity of what should be effective heat by that carried off by these products of combustion. It would be found that all wet gases, as he might call them, produced very much less effective heat than what might be called, in comparison, dry gases, namely, those into which no aqueous vapour entered. There was the advantage in this gas that you would not have any very great quantity of sulphur, and what there was, was not in a prejudicial form. He would take another opportunity of calculating the usual temperature of combustion, and send it to the *Journal*. As far as he could understand the apparatus, it seemed to him perfectly protected from anything like explosion; and there was not much danger of asphyxiation, which was another important point. He should also like to know whether Mr. Davies had ever tried an experiment in a grate full of asbestos.

Mr. Davies said he had tried it, but not in a very complete form, or in such a way as he should care to describe.

Mr. T. W. Hartley said he had been a great deal connected with the manufacture of water gas, but he differed from Sir Francis Knowles as to the necessary qualitities of such gases containing H, CO, and CO_2, because it was possible to resolve most of the CO_2 formed by the first combustion, into CO, thereby obtaining as much heating power as you would from hydrogen; in fact, more simply, because you had in CO, what he designated a dry gas. Nevertheless, in spite of the advantages which the gas seemed to possess, it was a fact that, as compared with these gases, which contained hydrocarbons, gases from water were infinitely inferior in heating power; and if this were so, it must necessarily be much more so with gases containing from 56 to 57 per cent. of nitrogen, which was inert, and quite useless for the purpose of heating; and in fact more than useless, because it absolutely prevented the flame obtaining the temperature necessary to give the best result. Some two years ago he saw Mr. Kidd's process in operation, and was much struck with it, believing that for smelting purposes on a small scale he had effected a very important invention, and thereby rendered a great service to the world; but he could not follow him into the conclusion that this gas could compete successfully with the gas obtained from the ordinary gas companies for the purpose of heating or lighting. With regard to heating, they were told already that it required something like five volumes of this to produce the same effect as one of ordinary coal gas. He was quite prepared to believe that it would require even more than that, but supposing it took only that, there would still remain the question of the cost of production; and he must say he was considerably startled by the statement that a thousand cubic feet of gas were produced from 10 lbs. of fuel. If the nitrogen were left out of the question, it came to something like 43 feet per lb. of fuel employed to produce CO, H, and CO_2, and that he was hardly prepared to receive readily, knowing as he did that in the production of water gas, though theory taught that you ought to get from a pound of carbon over 2,000 cubic feet, practice indicated quite a different thing. In America, where they had been trying this a good deal, it was found that in order to produce 1,000 cubic feet of hydrogen gas, they were obliged to employ 70 lbs. of fuel, the fuel being very analogous to the anthracite here employed. He was also startled by another statement, viz., that following an elevation of pressure within the tube you got an increased volume. He was not surprised at that in one sense, for the simple reason that by increased pressure you might increase the outward pressure through the pipe, and thereby add materially to the quantity of nitrogen, but he could not follow the tables showing the analysis of the gas obtained with different pressures. The difficulty he felt was to understand how the increased pressure could produce more perfect combustion, and thus a larger quantity of CO_2. It seemed to him the apparatus wanted greater depth to produce the best effects from the decomposition of the fuel, because experience had taught him that for the best results in the decomposition of steam you must have a tall column of carbon for it to pass through. The first impact converted the oxygen of water into CO_2, which by passing through a large mass of incandescent carbon took up another atom of carbon and became converted into CO.

Sir Francis Knowles said he might give a simple illustration of the importance of excluding the nitrogen. They all knew that the oxy-hydrogen blowpipe gave almost the highest temperature known, which would melt platinum, but if you attempted to burn the same gases with atmospheric air, you could only melt some of the more fusible metals. He would also suggest that nothing would be easier than to get rid of the CO_2 altogether, by passing the whole gas through a second retort. Then if you got rid of the nitrogen also you would have a gas of very considerable heating power.

Major Webber, R.E., said many interesting suggestions had been made, but those who were carrying on the process had for the last two years been almost overwhelmed by suggestions, nearly all of which had been experimented on. It was very natural that when a simple apparatus of this kind had been made and tried, and its results analysed, suggestions which involved altering the process to a great extent could not be carried far. The object of perfecting the invention of Mr. Kidd, which two years ago was in a very crude and imperfect form, had been to make the apparatus produce the best gas it was capable of producing, chiefly with the object of utilising anthracite coal. There was no doubt the gas was at present not perfect, but experiments had been made in the direction pointed out, and if they could be carried out on a larger scale he had no doubt better results could be produced. It was very easy to reduce the amount of nitrogen; you had only to use two or three generators, working them alternately, to produce from one or

other of them continuously a gas in which the nitrogen would be reduced to from 12 to 15 per cent.; and the value of the interior gas allowed to escape from one generator while the superior gas was being produced in the other was so small as hardly to effect the cost of the whole. With regard to the suggestion that a greater depth of fuel was necessary, the answer was very simple, that so long as the depth was sufficient to change the CO_2 into CO, leaving only the small amount which the analysis showed, that was all that was required. They had found by experiment that the depth here shown was as nearly as possible the best.

Mr. Gore, having had considerable experience in the generation of water gas, felt considerable interest in the question; but he fully concurred in the great defect of using gas for heating purposes, in which a large amount of watery vapour was produced. There was another important matter, and that was the large proportion of CO. He really thought the poisonous character of that gas, especially when used for domestic purposes, had not been sufficiently considered. His own impression was that the adoption of any system whereby CO was to be used for domestic purposes, was so dangerous as to interfere with its practicability. Experiments had lately been going on in America with regard to it, and readers of the *Scientific American* would, he thought, come to the conclusion that any form of using CO must be dangerous, and that, whatever might be done with it for manufacturing purposes, it should be avoided in households. He was convinced that ordinary coal gas was the most useful fuel which could be obtained; but then came the question whether the substitution of gaseous for solid fuel was not a step in the wrong direction, but as that was not the subject of discussion he would not go into it.

Mr. Kenelly said no doubt they ought to pay considerable deference to any information which came from America, but still he thought they were capable of taking care of themselves. As to the use of gaseous fuel, he thought it was a thing they were gradually coming to. After referring to the statements made by Mr. Davies as to the relative cost of common coal gas, and that thus produced, he said if these facts were really so, it was a startling thing, and it was nonsense bringing forward theoretical considerations in opposition to them. Whether there were a large amount of nitrogen or a small amount of CO_2, if the same effect could be produced from that which cost $\frac{3}{4}$d. as from 10d. worth of ordinary gas, and that seemed to be the result, there was something very valuable in the process. As to the question of danger, he happened to look into Mr. Leoni's establishment in the Strand a short time ago, and saw one of these apparatus at work in the basement. He did not know whether the sanitary authorities or the police were informed of it, but he saw no one looking very unhealthy or unhappy in consequence.

Mr. Brontin said he had been long connected with Wales, and, as President of the South Wales engineers, had had his attention much directed to the question of burning anthracite in an easy form. He believed that was now accomplished, and would direct Mr. Davies's attention to the fact that a very simple apparatus, very much on the principle now shown, had been adapted to burn it perfectly, and was applicable to almost any boiler. It consisted in the use of a steam jet thrown into a hollow bar perforated with holes, through which the steam escaped, and thus formed the gas of which the analysis had been given. It enabled large and small coal to be used, and there was no raking of the fire or anything of the kind. He had just gone into the question very roughly as to the quantity of heat thrown out by the gas as compared with the ordinary use of coal under a boiler, and he found that the quantity of heat in the case of gas was 627, as against anthracite at 795, so that there would be a disadvantage in the use of coal gas as compared with coal, were it not that he had always found, both in locomotives and under ordinary boilers, there was a large amount of air admitted, which had a considerable cooling effect, so that you did not get the absolute result from the burning of the coal. He had had a large experience in using gas with blast furnaces, and they found it impossible to do so without having a combustion chamber first, and allowing the products of combustion to pass through that which was required to be heated. The nitrogen would take up a certain amount of heat and carry it with it, and by using a Siemens' accumulator you could utilise that to any extent, so as really not to lose any of the elements of heat. Coupling that with the suggestion which had been made as to the conversion of CO_2 into CO again, he thought the process was one which was worthy of very serious attention. He felt quite certain that the march of intellect would lead them to pay less carriage on coal, because conveying gas would be much more simple. When they talked about bringing water from the north of England to London, he did not see why they should not in a lesser degree simplify costly transport by these means. No doubt Sir Francis Knowles knew the "black band" seam; it contained a large amount of carbonaceous matter, and just to test the power of the apparatus they had put it on the boiler fire, and burned out all the carbonaceous matter, leaving the "black band" on the bars, which remained untouched. That showed the great power of the apparatus very forcibly.

Mr. Hartley said there was a great difference in using gases immediately it was generated from a furnace in a state of ignition, and allowing them to cool, and then igniting them afterwards.

Mr. Davies, in reply, said one speaker had so far answered the remarks of another that there was really very little left for him to say. With regard to the danger of CO, you might say that every gas was dangerous. Marsh gas and olefiant gas were extremely explosive, but we were not afraid of admitting them into our houses, and, on the same principle, he did not think there was any danger of being poisoned with carbonic oxide. With regard to the great quantity of nitrogen, they knew, of course, that it only acted as a diluent, and carried off heat. But he had shown what could be done with this gas as it stood; he had compared it with coal gas, and the experiments he had mentioned showed that, notwithstanding the nitrogen, a great heating effect could be produced from it, and at a much less cost than with ordinary coal gas.

The Chairman said there could be no doubt that if the cost of the gas was what had been stated, it introduced a very important source of economy into domestic arrangements. The advantage of using gas in our houses for the purpose of combustion was one of which there could be no doubt, provided the element of cost could be successfully met. A gas fire was so easily regulated, and was so convenient in application, that it certainly appeared to him to be a more civilised arrangement than that of burning raw fuel. No doubt there were certain questions connected with this gas which, if solved, would probably increase its heating power very considerably, but apart from that they might look upon this as a great advance in the system of heating, and he was sure they would all concur in passing a vote of thanks to Mr. Davies for the exceedingly clear way in which he had brought it before them.

The Metropolitan Railway Company have decided to supersede their present mode of lighting the carriages by coal gas as quickly as possible by the adoption of Pintsch's compressed oil gas system, to which the Society's gold medal was awarded last Session. This system has also been adopted by the Great Eastern Railway Company for a large number of their carriages, and it has gained much favour and extenive adoption on German lines.

NOTICES.

THE LIBRARY.

The following works have been presented to the Library:—

Industrial Chemistry. A Manual for use in Technical Colleges or Schools and for Manufacturers, &c., based upon a Translation (partly by Dr. T. D. Barry) of Stohmann and Engler's German Edition of Payen's *Précis de Chimie Industrielle*, edited throughout and supplemented with chapters on the Chemistry of Metals, &c., by B. H. Paul, Ph.D. (London: Longmans, Green, and Co., 1878.) Presented by the Editor.

Minutes of Proceedings of the Institution of Civil Engineers, Vol. 51. Session 1877-8. Part 1. (London: 1878.) Presented by the Institution.

Knowles and others v. McAdam. Report of a Colliery Income-tax Appeal Case under the Act 37 and 38 Vict., cap. 16. Reprinted from the *Colliery Guardian*. (London.) Presented by Chadwicks, Collier, and Co.

The following Pamphlets have also been presented:—

On Supplying Newcastle and District with Water from Lake Ullswater, by R. S. Newall, F.R.S. (Newcastle-on-Tyne: Andrew Reid, 1875.) Presented by the Author.

The Malt-tax on Tillage; Morally, Socially, and Politically Considered, by Rufus Usher. (London: Wyman and Sons, 1878.) Presented by the Author.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at eight o'clock.

April 17.—*No Meeting.*

May 1.—"The Reforms in House Construction Demanded by Sanitary Science." By John Balburnie, Esq., M.A., M.D.

May 15.—"Dietaries, in their Physiological, Practical, and Economic Aspects." By R. M. Gover, Esq., M.R.C.P., Lond.

May 22.—"Controlling and Connecting Clocks by Electricity." By Frederick J. Ritchie, Esq.

African Section.

Tuesday evenings, at Eight o'clock.

April 30.—"The Progress of Agriculture and Stock Farming in the Colony of Natal." By Peter C. Sutherland, Esq., M.D., Surveyor-General of the Colony. The chair will be taken by J. A. Froude, Esq.

Chemical Section.

Thursday evenings at eight o'clock.

April 25.—"The Purification of Water by Filtration." By Gustav Bischof, Esq., F.C.S.

May 9.—"Some Recent Improvements connected with Alkali Manufacture." By James Mactear, Esq.

May 23.—"The Position of Chemistry in a System of Technical Education, as illustrated by some of its applications." By J. M. Thomson, Esq., F.C.S., of King's College, London.

Indian Section.

Friday evenings at eight o'clock.

May 3.—"The Telegraph Routes between England and India." By Major Bateman-Champain, R.E.

May 17.—"Agriculture in India." By F. C. Danvers, Esq.

Cantor Lectures.

Monday Evenings, at Eight o'clock. The Third Course, for the present Session, will be on "Some Researches on Putrefactive Changes, and their Results in relation to the Preservation of Animal Substances." By B. W. Richardson, Esq., M.D., F.R.S. The Second Lecture will be delivered on Monday, April 15; the dates for the remaining Lectures will be as follows:—May 6, 13, 20, 27.

Members can admit one friend to each lecture. Books of Tickets for the purpose were supplied to all the Members at the commencement of the Session.

MEETINGS FOR THE ENSUING WEEK.

Mon.... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures). Dr. B. W. Richardson, "Some Researches on Putrefactive Changes, and their Results in Relation to the Preservation of Animal Substances." (Lecture II.)
Royal United Service Institution, Whitehall-yard, 8½ p.m. Captain P. H. Colomb, "Steam Power versus Sail Power for Ships of War"
British Architects, 9, Conduit-street, W., 8 p.m. Dr. Alder Wright, "The Chemical Disadvantage of Sulphur Joints in Masonry." 2. Mr. Thomas Blashill, "The Vexed Question of Oak or Chestnut in Old Roofs."
Medical, 11, Chandos-street, W., 8.30 p.m.
Asiatic, 22, Albemarle-street, W., 3 p.m.
Victoria Institute, 10, Adelphi-terrace, W.C., 8 p.m. Mr. G. Race, "The Formation of Valleys."

Tues.... Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Discussion on "The Thames Embankments." 2. Messrs. R. T. Mallet, H. Lamhert, and F. M. Avern, "The Ravi, Alexandra, and Jhelum Bridges, Punjab Northern State Railway."
Statistical, Somerset-house-terrace, Strand, W.C., 7¾ p.m. Mr. Hyde Clarke, "The Debts of Sovereign and Quasi-Sovereign States."
Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.
Zoological, 11, Hanover-square, W., 8½ p.m. 1. Prof. J. O. Westwood, "Observations upon the Uraniidæ, a family of Lepidopterous Insects, with a Synopsis of the Family, and a Monograph of Coronilia, one of the Genera of which it is composed." 2. The Marquis of Tweeddale, "Contributions to the Ornithology of the Philippines, No. VIII. On some Luzon Birds in the Museum of Darmstadt." 3. Mr. T. Jeffrey Parker, "Further Notes on the Stridulating Organ of *Palinurus vulgaris*." 4. Dr. O. Finsch, "A New Species of Finch from the Feejee Islands."
Royal Colonial, Pall Mall Restaurant, 14, Regent-street, S.W. Mr. Sandford Fleming, "Canada, and its Vast Undeveloped Interior."
Royal Horticultural, South Kensington, S.W., 11 a.m.

Wed.... Meteorological, 25, Great George-street, S.W., 7 p.m.
Geological, Burlington House, W., 8 p.m.
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m. Sir Patrick Colquhoun, "The Historical Outlines of the Buddhist Faith."
Archæological Association, 32, Sackville-street, W., 8 p.m. 1. Mr. H. Syer Cuming, "Good Friday Buns." 2. Mr. John Brent, "Roman Remains at Canterbury, Recently Discovered."
Obstetrical, 53, Berners-street, Oxford-street, W., 8 p.m.
Society for the Development of the Science of Education, United Westminster (Endowed) Schools, Alexandra-street, Victoria-street, S.W., 7.30 p.m. Mr. W. H. Herford, "Faults in the Usual Means and Methods of Teaching History to Children."

Thur.... Linnean, Burlington House, W., 8 p.m. 1. Mr. Howard Saunders, "The Geographical Distribution of the Gulls and Terns (*Laridæ*). 2. Dr. Maxwell Masters, "Remarks on Root Growth." 3. Mr. J. Clarke Hawkshaw, "Notes on the Action of Limpets (*Patella*) in Sinking Pits in and Abrading the Surface of the Chalk at Dover." 4. Mr. R. Irwin Lynch, "The Fertilisation of *Meyenia erecta*."
Chemical, Burlington House, W., 8 p.m. 1. Dr. W. A. Tilden, "Terpin and Terpinol." 2. Mr. Y. Bowrey, The Poisonous Principle of Urechites Suberecta." 3. Mr. A. Wynter Blythe, "The Temperature at which a few of the Alkaloids sublime, as determined by an Improved Method."
Society for the Encouragement of the Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. Alfred Gilbert, "The Life and Works of Mendelssohn."
Numismatic, 4, St. Martin's-place, W.C., 7 p.m.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,326. Vol. XXVI.

FRIDAY, APRIL 19, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

PARIS EXHIBITION.

The following letter has been received by the Council of the Society of Arts, from his Royal Highness the Prince of Wales, in reference to the forthcoming Paris Exhibition :—

Marlborough-house, Pall-mall, S.W.,
13th April, 1878.

Sir,—As President of the Royal Commission for the Paris Universal Exhibition, I am desirous of ascertaining what assistance can be given towards the visit of artisans, who might be delegated to examine and report upon the special technicalities of the various industries which will be displayed at this Exhibition.

Similar reports were made during the Paris Exhibition of 1867; and the Society of Arts, always foremost in promoting such undertakings, took an important part in bringing together the very valuable documents which were published at that time.

At the Vienna Exhibition, also, reports of a like nature were drawn up, and a small volume containing much interesting information was the result.

In the present instance, having undertaken the responsibility of the executive arrangements connected with the Paris Exhibition, I should be glad to hear that the Council of the Society of Arts find that it is in their power to co-operate with the Royal Commission, in providing for the funds and organisation which will be necessary in order to carry out the object in view.

The Royal Commission will contribute a sum of one hundred guineas, out of the vote which has been placed at their disposal for the British section; and as a further proof of the interest which, in common with my colleagues, I take in the promotion of these visits, I propose to request certain members of the Royal Commission to form themselves into a Committee, for the purpose of cooperating with the Council of the Society of Arts.

I am, Sir,
Your obedient Servant,
(Signed) Albert Edward P.,

To P. Le Neve Foster, Esq.,
Secretary of the Society of Arts.

The Council, at their meeting on Monday, expressed their willingness to undertake the duties proposed by His Royal Highness, and to render such assistance as lay in their power to further the object in view. For this purpose they nominated a Committee to co-operate with the Committee appointed by His Royal Highness, and voted 100 guineas towards the expenses of the undertaking.

NATIONAL WATER SUPPLY.—HEALTH AND SEWAGE OF TOWNS.

The Congress on National Water Supply will be held on Tuesday and Wednesday, 21st and 22nd May, and will be followed on Thursday and Friday, 23rd and 24th May, by that on the Health and Sewage of Towns.

CANTOR LECTURES.

The Second Lecture of the Third Course, on "Some Researches in Putrefactive Changes, and their Results in relation to the Preservation of Animal Substances," by B. W. Richardson, M.D., F.R.S., was delivered on Monday evening last, the 15th inst. These lectures will be published in the *Journal* during the recess.

ADDITIONAL LECTURES.

EXPLOSIONS IN COAL MINES.

By T. Wills, F.C.S.

Lecture I.—Delivered January 28th, 1878.

The commercial position and industrial prosperity of a nation are essentially dependent on the extent of its available mineral resources, and on the manner in which these resources are utilised. The chief of these minerals at the present time, and that one which has become necessary for the successful working of the rest, is the fossil fuel—coal.

Going backward in the industrial history of any people, we should find in the earliest times those processes only in existence which supplied in the rudest manner the essentials of food, clothing, and shelter, and the first demands made upon fuel—demands which have continued and increased ever since—would be for the supply of warmth, the cooking of food, and the production of artificial light. As civilisation has progressed, greater and more extended calls have been made upon the natural resources of the crust of the earth, to supply the ever-increasing wants of mankind. The greater number of these valuable native substances, however, do not exist in that state or form in which

they became useful to man, and, in order that this may be the case, work had to be performed. The chief source of this work-doing power has been more and more found in some form of combustible material or fuel. Coupled with this, there are those chemical processes which, from their nature, require the use of combustible matter, *i.e.*, the extraction of metals from their ores, and the preparation of the various chemical products. These considerations have gradually made the supply of available combustible matter a qestion of capital importance to any nation or country.

The existence and all but universal distribution of vegetable life upon the earth, would naturally lead to the utilisation of woody fibre as the first source of fuel, and, for a very considerable period, this was almost the sole material employed as a combustible, with the exception of the very restricted and local use of certain kinds of native bitumen, while animal oils and fat were also occasionally employed as sources of artificial light. Peat and charcoal are modifications of woody fibre, the use of which exhibits an advance in the knowledge of fuel, especially in the case of the charcoal, the relative value of which would be arrived at only by experiment. There is no record of any period during which the use of fire, and consequently fuel, was unknown, neither have any people been found in so low a state of barbarism as to be without its use. In religious rites and ceremonies, for the preparation of food, and in procuring warmth, it has at all times held a prominent position. Man has been aptly termed a "fire-making animal," and accepting the definition in its broadest sense, with all that it involves, no bad notion would thus be obtained of the position he occupies in the natural world.

In all probability, in early times, a much larger area of the earth's surface was covered with woods and forests than we have any record of; at any rate, we know this to have been the case with European countries, and the wood of forest trees forming, when dry, such excellent fuel, there would be no occasion to seek for any further source of combustible material; when, however, the demand became large, and the available local area was comparatively small, the disappearance of woodland would be rapid, seeing that the slow operation of growth, even if ever so carefully promoted, which was never the case, would be incompetent to keep pace with the consumption, the transport of wood from place to place would be a difficult matter, and in this way it would come to pass that a serious problem as to the continued supply of sufficient fuel would have to be faced. In England, this had come to be the case somewhere about the beginning of the 16th century, when the destruction of woods and forests began to attract attention; but had there been no other source of fuel ready for development, this attention would have come too late to be of any service, as there had previously been great neglect in the planting and raising of young trees. From a proclamation of Edward I., in 1306, it would appear that there must have been in his reign an abundant supply of wood fuel; for, owing to the nuisance arising from the burning of certain varieties of *sea-coale*, the proclamation commands all persons in London and its suburbs to make their fires of wood. In Henry the Eighth's reign also, the whole kingdom was plentifully stocked with timber; but during the civil war of 1642 many forests were entirely obliterated. At about this time also the amount of tillage land was largely increased, and the establishment of glass and iron works, and the building of ships, caused such a drain upon the supply of wood, that in 1678 a deficiency of oak timber was feared for the supply of the Royal Navy. The planting of trees was systematically neglected. In the reign of Queen Elizabeth, the burning of stone coal was prohibited in London during the sitting of Parliament. Stowe, in his "Annals," 1632, says—"Such hath been the plenty of wood in England for all uses that within man's memory it was held impossible to have any want of wood. . . . . . . yet at the present, through the great consuming of wood, and the neglect of planting woods, there is so great scarcity of wood throughout the whole kingdom that, not only in the City of London, all haven towns, and in very many parts within the land, the inhabitants in general are constrained to make their *fiers* of *sea-coale* or pit-coale, even in the chambers of honourable personages, and through necessitie, which is the mother of all arts, they have of very late years devised the making of iron, the making of all sorts of glass, and burning of brick with *sea-coale* or *pit-coale*." Writers might be multiplied who dealt with the subject from various points of view when once attention had been drawn to it. In 1634, Wither, a poet, wrote—

> "—— The havoc and the spoyle,
> Which, even within the compass of my days,
> Is made through every quarter of this isle
> In woods and groves, which were this kingdom's praise."

That a state of things would come about in which there should be a want of wood fuel is perfectly evident to us now, on looking back to the history of this time.

David Mushet gave an account, in 1810, which showed conclusively the inability of wood to supply the growing wants of industry. He states that a blast furnace at work the whole year, and turning out during that period 1,000 tons of pig-iron, would require, if worked with charcoal, 12,000 tons. This charcoal would be equivalent to 143.360 cubic feet of wood. The woods usually found in the neighbourhood of the works would yield not more than 1,200 cubic feet of timber per acre; consequently, for the supply of one furnace, as above, 120 acres of forest land would have to be cleared per annum, and, taking the wood at 18 years' growth, it would be requisite to have 1,400 acres set apart for this special purpose. At the commencement of the 17th century, it is stated that there were 800 mills for iron-making in Great Britain.

Few, if any, of these writers who deplored the disappearance of woods recognised the vast importance to a people of the large supply of a good and serviceable fuel, or saw the necessity of maintaining, and still further developing, the industrial power of this country, yet undoubtedly it was from this point of view that the most serious side of the problem presented itself; but here, as in so many other cases, the necessity, once felt, was immediately followed by the opening up of new sources for the supply of this want. Attention was from this time given to the little known sea or pit coal, the supply of which had hitherto been precarious and

fitful, and, it may be added, expensive, a chaldron of Newcastle coal being valued at 4s. in London in the time of Henry VIII.

The first licenses to dig coals were granted to the Burgesses of Newcastle as early as Henry III.'s reign, and, in 1281, a fair trade was done in that fuel. In the reign of Edward II. coals were first sent from Newcastle for the benefit of those trades which required fuel.

Some varieties of coal have probably been known from a very early date, but the authentic records concerning coal are not of very great antiquity. One or two classical passages are usually quoted as evidence of the knowledge of the ancients upon the subject (see Theophrastus and Pliny). The Thracian stone, mentioned by Pliny and other writers, has been by some considered to be coal, but the references are so slight, and of such small importance, that it appears certain that, if the substance mentioned by them be really that which is known to us as coal, it was little more than a curiosity, and its use very restricted.

It is probable that the Romans, during their presence in this country, became familiar with the value and use of coal, but whether this came about by finding the natives of these islands in possession of such knowledge, or whether it was one of the many developments of natural resources which are directly traceable to the invaders, it seems impossible to say; there is, however, no evidence to show that, in their own country, there was any knowledge of such fuel. Pennant says that the Britons had a primitive name for coal, "Glo." There have been quantities of cinders found in the midst of Roman remains in Britain which afford proof that coal was known and used.

The coal trade took its rise in that part of England which has maintained its supremacy in this direction ever since, *i.e.*, in the Newcastle district, and the date at about which the trade in coal became developed into a real commercial industry was the beginning of the 13th century. The first coal workings known are said to have been established in Belgium in 1198. In 1639, Newcastle supplied two-thirds of the coal used in this country. In 1615, there were employed in the coal trade of this port 400 ships; one-half supplied London and the other the rest of England. In 1660 there were brought to London from Newcastle 265,571 tons; in 1670, 355,821 tons; and in 1690, 395,357 tons. In 1660 the entire coal produce of the United Kingdom appears to have been only about 2,225,000 tons; in 1700, about 2,750,000 tons; in 1750, 5,000,000 tons; in 1800, 10,000,000 tons; in 1816, 16,000,000 tons; in 1854, 64,500,000 tons; in 1869, 107,000,000 tons; and in 1872, 131,600,000 tons.

Coal is found in almost every quarter of the globe, and in every zone, including the Arctic; but England has, since the introduction of coal as a fuel, maintained her position as the first and chief coal-producing country, having always furnished more than one-half of the entire amount raised in the whole world. The relative position of the several countries taking part in this trade may be well seen, by reference to a paper by Victor Bouhy, in the *Revue Universelle des Mines* for 1875.

The first knowledge of coal would not involve the process of mining, as it would undoubtedly be derived from those surface outcrops which, owing to a disarrangement of the strata, or denudation of strata by water, occur at various parts of the earth's surface, to a greater or less extent, in every coal-bearing country, notably in the valleys of the rivers in Northumberland, Durham, and Cumberland, in the great Appalachian coal-field in North America, and on the shores of the Arctic sea. Lyell states, that the Rivers Monongahela, the Alleghany, and the Ohio, have running along their banks, and parallel to them, several exposed seams of coal, some as much as 10 feet thick, and the recent Arctic expedition discovered a seam of exceedingly good coal in Grant Land, latitude 81° 44′ North, which is found exposed on one side of a gorge through which a stream descends.

The rivers so running through coal districts would certainly carry down considerable quantities of coal, and when the value of the fuel began to be known, quarrying would only have to be adopted in order to obtain the necessary supplies. As soon, however, as it became recognised that the coal lay in strata at a greater or less distance below the level of the ground, the obvious utility of sinking mines for the purpose of getting at and winning the material would be seen, and the advance of geological science would cause this mode of procedure to become at once the easiest, while it would be in most cases the only possible method of excavation.

Coal is mainly found in two parts of the great divisions of geological periods. In the so-called primary division, it is found at the base of the stratified rocks constituting the secondary, and above the generally recognised primary division, usually separated therefrom by the carboniferous limestone, that is to say, in other words, that the coal is found in strata above the Devonian or old red sandstone, and below the permian or dolomites and magnesian limestones. Again, coal is found widely removed from this position, and of a much more recent date in the miocene division of the tertiary formation; this latter coal, which includes the brown coals and lignites, is, however, mostly of a different nature to that found in the former position, which constitutes the true carboniferous formation. The occurrence of coal is not, however, confined to these strata, but is found in various positions from the Devonian down to the recent tertiary deposits.

The most important coal-bearing strata is in Great Britain the carboniferous, of which, however, the coal measures, constitute but a very small portion. The carboniferous division includes strata of shale and sandstone, of coal, of millstone grit, and mountain or carboniferous limestone, and in some parts also a slate and a yellow sandstone below the limestone.

In the North of England, Professor Phillips estimates the thickness of the carboniferous strata at 3,000 feet, in which the total thickness of the coal seams does not exceed 60 feet, and in South Wales, Lyell states that the thickness of the coal-bearing strata has been ascertained to be as much as 12,000 feet, of which the numerous coal seams occupy but a fraction; and again, in Germany the thickness of this system of rocks is 20,000 feet. The seams of coal distributed through the carboniferous formation are very numerous, and of a thickness of from a quarter of an inch to several

feet. There is one notable seam in Staffordshire known as the 10-yard seam. Probably, at the period of the formation of the coal, it was deposited in horizontal and parallel layers, but by the action of various natural forces, the strata appear at the present time in a more or less contorted fashion; frequently, however, exhibiting the form of a basin, with the coal lying at the greatest depth below the surface at the centre.

In the early history of coal-mining, the coal was sought for at that distance least removed from the surface, and only as the seams thus found have been profitably worked out, and as the demand for coal has necessitated the working of larger areas, deeper shafts have been sunk; this tendency to go to greater and greater depths has been a true measure of the growing development of the industry. From recorded information in 1709, it appears that, in the important Newcastle coal field, the average depth of the pits was from 20 to 30 fathoms, and a few only from 50 to 60 fathoms (120 to 180 feet). In 1787, the greatest depth worked in the Tyne collieries was 105 fathoms, while at the present time, the average depth of working is considerably more than this.

The Arley Mine at Rose-bridge, near Wigan, is 408 fathoms deep. Mines at Pendleton, near Manchester, are 268 fathoms. At the Dukinfield Colliery, the depth is 343 fathoms, and the celebrated Monkwearmouth pit, which has been worked since 1834, is 265 fathoms deep. In Belgium even greater depths are found, in some pits as great as 500 fathoms. A pit near Charleroi is 440 fathoms. There is a limit to the depth of practical working, nothing approaching to which has however yet been obtained; this limit was fixed by the Coal Commission of 1870 at about 4,000 feet below the surface; it is brought about chiefly by the increase of temperature, which occurs as the depth becomes greater, the temperature rising pretty uniformly 1° F. for every 60 or 70 feet; this fact causes the problem of ventilation to become difficult, in addition to the necessity of causing men to work for considerable periods in a highly heated atmosphere. The enormous increase of pressure, which occurs as the depth becomes greater, also forms a serious obstacle to successful working; it is stated that, at the Black Mine of the Dukinfield Colliery, depth 2,500 ft., the pressure is such as to crush in circular arches of brickwork 4 ft. thick, and, in one case, a pillar of cast-iron, 12 in. square, supporting a roof only 7 ft. in extent, was snapped in two.

The temperature of the earth becomes constant, summer and winter, in England, *i.e.*, is unaffected by surface changes at a depth of 50 ft. A constant temperature of 98° F., or blood heat, would be reached at a depth of about 3,000 ft.

It is probable that the whole of the coal in any district will never be removed, as in some places it lies buried 6,000 ft., 8,000 ft., or even 12,000 ft. below the surface. The available coal, however—*i.e.*, the coal occurring at a depth not greater than 4,000 ft.—was estimated by the Coal Commission of 1870 as follows, excluding seams of less than 1 ft. in thickness:—

	Thousand million.
The South Wales district......	32,456,208,913 tons.
Midland district	18,172,071,433 „
Northumberland and Durham..	10,036,660,236 „

The coal below the depth of 4,000 feet is relatively small.

The coal-bearing strata of North America is 70 times greater in area than in England.

There is no coal being formed at the present time, consequently, although the above figures are large, and the quantities capable of affording a sufficient supply for a considerable period, eventually a state of things must necessarily ensue which will be comparable with the period when the exhaustion of the available wood supply was imminent. It is necessary here, before going further, to inquire into the origin of coal, and the probable manner in which it has been deposited in its present position. I propose to treat of this part of the subject very briefly, as it has formed the subject-matter of many lectures, delivered in this room and elsewhere, and the literature dealing with it is large; but to omit it altogether would be to sacrifice a certain amount of clearness and completeness in reference to our present purpose.

The purely vegetable origin of coal, although now universally accepted, has only been recognised within modern date, and through the medium of a considerable amount of discussion, and is due to a close examination of the coal itself, also to the recognition by geologists that the several strata represent successive periods through which the earth has passed.

All the coal seams lie between two beds of shale, the lower one being known as the under-clay, the upper as the roof of the coal. In the under-clay there occur fossil stems and roots of certain plants and trees, while in the upper shale the fronds, leaves, seeds, &c., of known orders of plants may be found in immense abundance. Probably no fossil flora is so well known as that of the coal measures, so that not only the nature of, but the position in which the plants grew and the extent of their development is distinctly recognisable. The fossil remains in the under-clay or *Stigmaria*, are scarcely ever wanting, and are, in reality, the roots and rootlets *in situ* of fossil trees, chiefly of the order *Sigillaria*. Within the body of the coal itself little direct evidence is found of vegetation, as the change has in this substance proceeded so far as to obliterate all organised structure; by some few observers, however, and by employing very thin microscopic sections, traces of ligneous structure have been found even here. The shale lying above the coal is usually wonderfully full of impressions of leaves, seeds, and small stems in a state of great preservation.

About 500 distinct species of plants, including 250 ferns, have been recognised as belonging to the coal period. The principal varieties occurring are the sigillaria, calamites, lepidodendra, equiseta, as well as various lichens, mosses, lycopodiums, and, in some cases, conifers. Many of these resemble the existing species, differing, however, in the important particulars of luxuriance of growth and enormous development; thus the miniature club moss at the present time is represented during the coal period by trees, frequently of from 30 to 40 feet in height. The most important of all the coal-forming plants was the sigillaria, which occurs in some places in such quantities, that whole coal seams are entirely formed from its remains. The great majority of club mosses growing at the present time are not more than six inches

long, and the largest of them is not more than six feet high; a fragment of a fossil coal club moss has been found near Newcastle, 3 ft. in diameter, and 49 ft. long; a portion of the trunk of a sigillaria has also been found 7 ft. long, and 15 ft. in circumference.

The fossil remains of these plants preserve with great accuracy their outward form, the interior, however, having been entirely replaced with sandstone and shale. This is owing to the fact that the interior woody fibre suffers change and decay much more rapidly than the bark, a result which is seen in old decaying trees still standing at the present time.

The vegetable origin of coal being thoroughly established, the precise manner in which the layers or seams have been formed is still doubtful. The period during which this formation proceeded is, geologically speaking, well marked, and the occurrence of coal in almost every part of the globe, containing the remains of the same genera of plants, points to its almost universal nature. Two theories have been maintained for a long time—the one that the plants and trees forming the coal flourished and died upon the spots where the coal is now found, and the other that the débris of forests drifted in enormous quantity into the deltas of rivers, and was there eventually submerged. That the coal has been submerged is admitted, and is proved. The coal is interstratified with beds of sandstone and clay, formed doubtless by the action of water; also it has had washed out of it all the matter soluble in water; marine remains, however, do not occur very plentifully, and hence it is probable that the submergence was beneath the surface of fresh water, or it may have been of land-locked oceans. The theory that coal was formed from plants growing on the spot has, however, received the greatest amount of evidence. The occurrence of the roots and stems still joined *in situ*, the invariable occurrence of *stigmaria* in the underclay, and the very delicate impressions of leaves and fronds found in the upper shale, are hardly compatible with the drift theory. The underclay was probably the soil in which the coal plants grew, and the successive generations would flourish and decay upon the surface; after the lapse of time a considerable thickness of peat-like material would have accumulated, and then, either by depression of the land or the rising of the sea level, the water would flow over this vegetable matter, consolidating it, and eventually causing the deposition of beds of mud and clay or sand upon it. The repetition of this process, which must have occurred to form the successive coal seams, would require the sediment to increase so as to rise above the surface of the water, or the water to be drained off by another alteration of level, in order to leave the soil again exposed for a further period of vegetable growth. Whatever may have been the exact nature of the accumulation, there can be no doubt that the residue of enormous masses of vegetation is represented in the coal measures. The atmosphere of the period was probably warm and very humid; there is no direct evidence, however, to indicate the presence of a large amount of carbonic acid gas in it than at present.

We have no reason to believe that the composition of the trees and plants of the coal period differed in any essential way from the composition of the same kind of growth of the present time; woody-fibre formed, then as now, the substantial part of the vegetable matter, and this is the substance which, by successive changes, has become converted into coal. The essential constituents in the composition of wood are carbon, hydrogen, oxygen, and nitrogen, together with a small quantity of mineral matter derived from the soil, which, upon the combustion of the wood, remains as ash; the proportion in which these bodies are formed does not vary much in any kind of plant, the fundamental structure being depended upon a body already mentioned, known as cellulose, and in addition to this all wood contains a variable amount of water. The composition of the woody tissue is represented by the chemical formula $C_6H_{10}O_5$, and its per-centage composition is the following:—

Carbon	44·44
Hydrogen	6·17
Oxygen	49·39

In the passage of wood into coal it is this woody fibre to which attention must be directed, as it is the changes taking place in its composition which have brought about the transition into coal.

In the following table the first stage of decomposition is exhibited in the case of oak wood:—

Composition of Decayed Oak Wood, Exclusive of Ash and Water.

Carbon.		Hydrogen.		Oxygen.	
51·17	....	5·66	....	43·17	(*Percy.*)

The composition of the same wood fresh is not given, but in the following table the composition of three typical kinds of wood is shown, together with that of three kinds of coal; it will be seen that oak forms one of the woods:—

Per-centage Composition.—Exclusive of Ash and Water.

	Carbon.	Hydrogen.	Oxygen and nitrogen.
WOOD.			
Oak	50·69	6·03	43·28
Beech	49 94	6·08	43·95
Birch	51·93	6·31	41·76
COAL.			
Lignite—Bovey, Devonshire....	69 53	5·91	24·56
Hartley Coal—Northumberland......	80·67	4·76	14·57
South Wales—Swansea	94·05	3 38	2·57

These are chosen from a large number of analysis which vary in different specimens, but they represent fairly typical samples, and it will be seen at once that the main difference between the wood and the coal consists in the loss by the wood of hydrogen and oxygen, and the increase of the carbon. It thus becomes necessary to understand the changes which may bring about such an alteration in composition.

If wood is burnt in the presence of air, excess of air, the carbon is entirely burnt into carbonic acid gas $C + O_2 = CO_2$, and the hydrogen into water $H + O = H_2O$, the oxygen of the coal taking

The two principal laws governing this matter are part in the actions to the extent to which it is present. It will be seen, on referring to the composition of woody fibre, that the amount of oxygen present is only sufficient to unite with the hydrogen to form water, so that the whole of the oxygen which is required to oxidise the carbon has, when the wood is burnt, to be obtained from the air, so that when 100 lbs. of woody fibre are completely burnt, 118 lbs. of oxygen are required in addition to the amount of oxygen which the wood contains. If, however, the wood is heated in such a way as to be out of contact with air, the case is different, the oxygen contained in it mainly unites with the hydrogen to form water, but a portion unites at the same time with the carbon and the hydrogen, to form tar, wood naphtha, carbonic acid, carbonic oxide, acetic acid, &c., while a portion of the hydrogen also unites with carbon alone, to form certain hydrocarbons; but these products are all volatile, and hence at a high temperature are expelled, with the necessary consequence that the residual carbon, which is largely in excess of either hydrogen or oxygen, remains; in this way charcoal is produced, which consists essentially of carbon and the fixed inorganic matters of the wood. If instead of being treated in this manner the wood is allowed naturally to decay, the result is very much the same, water, carbonic acid, and a certain amout of the simplest hydrocarbon, marsh gas, being formed, the residue being a kind of peat, or humus, containing a greater per-centage of carbon than the original wood; this process is, however, far from being as complete as in the previous case, and there is also the absence of the higher and more condensed hydrocarbons. The formation of coal may be regarded as a process intermediate between that of heating the wood out of contact with air, and that of allowing the wood to decay in the natural manner in contact with air. In all probability a certain amount of natural decomposition went on, before the remains of the coal forests were imprisoned beneath the superincumbent strata of mud and sand; but, after this had taken place, the free access of air was prevented, and the rise of temperature, due to two causes, the slow oxidation of the woody fibre, and the increasing depth below the surface, coupled with considerable pressure, would make the changes occurring more analogous to a slow "destructive distillation" of the wood. Knowing the composition of wood and of coal, and also certain circumstances to be hereafter mentioned, which are brought to light during the excavation, it is possible, by certain typical actions, to represent approximately the changes which have taken place; this has been exhaustively done by Gustav Bischof, of Bonn, who states that the conversion of wood into coal may have come about in either of four several ways, or some combination of them—

1st. By the separation from the wood of carbonic acid, CO_2, and carburetted hydrogen, CH_4.

2nd. By the separation of carbonic acid and water, H_2O.

3rd. By the separation of carburetted hydrogen and water.

4th. By the separation of carbonic acid and carburetted hydrogen.

Either of these changes will cause a reduction of the hydrogen and oxygen. The partial separation of oxygen, hydrogen, and carbon from wood, as water and carbonic acid, is an established fact, and also the partial separation of carbon and hydrogen as carburetted hydrogen when the change takes place under water. The precise extent to which either of these actions would proceed would without doubt be largely influenced by local circumstances, but the tendency in any case would be towards the gradual removal of the oxygen and hydrogen, together with a portion of the carbon, and the consequent increase in the proportion of the latter in the residual mass. It is probable that the third action, *i.e.*, the formation of carburetted hydrogen and water, has been the most extensive, as the quantity of carbonic acid found in the coal seams is not proportionately great. A number of hypothetical reactions might be written expressing such a decomposition of the wood. The following is a specimen:—

$$C_6 H_{10} O_5 = CO_2 + CH_4 + 3 H_2 O + C_4$$

Circumstantial evidence of the truth of the above statements is forthcoming from the coal seams themselves, in which the several varieties of coal obtained may be regarded as representing so many stages or changes. The following table, partly compiled from the analysis of Dr. Percy, exhibits this fact:—

Table showing the gradual change in composition from Wood to Coal. Carbon = 100.

	Carbon.	Hydrogen.	Oxygen.
Wood	100	12·18	83·07
Peat	100	9·83	55·67
Lignite	100	8·37	42.42
Staffordshire coal—10-yard seam	100	6·12	21·23
Steam-coal—Tyne	100	5·91	18·32
Anthracite—South Wales	100	4·75	5·28
Anthracite—Pennsylvania	100	2·84	1·74
Graphite	100	—	—

The occurrence of carbonic acid gas and marsh gas in coal mines and in strata, which contain any large amount of organic matter is, in view of the above facts, perfectly intelligible. The greater portion of these gases formed over the period of change has found its way to the surface, and has diffused; that portion which is now found upon the sinking of mines has been imprisoned in fissures and cavities in the coal, and has also, to a large extent, been absorbed or occluded by the coal itself under an excessive pressure. The sinking of a shaft, or the driving of a level or gallery, cuts through a number of these fissures, which, upon the relief of the pressure, frequently become outlets for the gas pent up over a large area, and at the same time the free communication with the external air, tending to establish an equilibrium of pressure, causes the absorbed gas to issue from the coal itself. As the amount of the gas absorbed by the coal varies with the pressure, newly won coal always gives off small quantities of gas, and this continues for some time after its exposure to air; this fact

has been the cause of some explosions which have occurred when coal has been stored in any quantity, shortly after having been raised, in closed places, such as the holds of ships. As in all working coal mines fresh surfaces are continually being opened, these circumstances are always being renewed.

The Ventilation of Coal Mines.

Wherever human or animal life has to be maintained, a supply of atmospheric air must be provided either by natural or artificial means. The animal economy requires a constant supply of oxygen, for the oxidation of the carbonaceous food, and the consequent revivification of the system, the exhaled air becoming so vitiated by the presence of the products so formed as to rapidly render it entirely unfit for this purpose.

In the following table the composition of normal atmospheric air is given :—

	Volumes.		Weight.
Nitrogen	79·19	..	76·99
Oxygen	20·81	..	23·01
	100 00		100·00
Carbonic acid	·04	..	·06
Aqueous vapour (about) ..	1·4	..	·87
Ammonia variable about one part per million.			

These three latter bodies, although not considered as entering into the composition of pure air, are always found in our atmosphere. A man requires, in order to dilute the products of respiration to their normal amount, to be supplied with 3,000 cubic feet per hour ; this amount has been fixed as a perfectly normal and healthy one, under which a man may remain for an indefinite length of time. If the amount of air containing not more than six vols. of carbonic acid per 10,000 vols. of air is not forthcoming, continuous working in such an atmosphere, without any other source of vitiation, will be productive of bad results upon the system, and the seriousness of these results will depend upon the extent of the vitiation and the length of time of the exposure to its influence. The effect of breathing bad air is to increase the rapidity of respiration, and to lower the pulse, and, after a time, to produce certain forms of lung disease. If the combustion of gas, candles, or oil takes place at the same time in the same space, a larger quantity of fresh air is needed ; two candles or one fairly good lamp may be taken as equal in vitiating power to one adult human being. In underground places there are other important vitiating causes, exhalations of carbonic acid, suspended dust and dirt, powder-smoke, &c. Under these circumstances the supply of air must be proportionately increased. A man breathes into his lungs about one-fifth of a cubic foot of air per minute, and converts 7 per cent. of this into carbonic acid gas, which, with 25 per cent. of free nitrogen, and $66\frac{2}{3}$ per cent. of unchanged air, he exhales. The largest lamp used in mining gives off less carbonic acid than a workman.

In the case of ordinary buildings or enclosed places upon the surface of the earth, the necessary supply of air is, in too many instances, left to nature, while her means of producing the desired result are seriously crippled ; still, by the action of well-known laws, a supply of unvitiated air, however inadequate for a healthy state of living, is provided in sufficient amount to sustain life. —1st, that warm air possesses a density less than than that of cold, whereby the tendency to create a current is obtained which will carry the air away from any given point, replacing it with air from some other and colder source ; and, 2nd, the tendency of all gases to become thoroughly and permanently mixed, or diffusion. In ordinary cases, the latter exerts a very powerful, although but little recognised, influence in the dilution and removal of vitiated air. The action of the laws of diffusion is all the more important, as the process proceeds without there being any free contact of the air or gas, as, for instance, through the walls and ceilings of buildings ; so that a space in which there might be no outlet or inlet, whereby a current of air could be established according to the first principle, could, nevertheless, be ordinarily more or less efficiently ventilated by the passage of air through the walls of the building ; it is, doubtless, owing to this latter fact that the matter of ventilation has been so systematically neglected. Had the case been such that air could only be obtained by having proper and sufficient openings for inlet and outlet, the arrangement of these in all kinds of buildings would have been absolutely necessary. In passing, it may just be mentioned, in view of the above, how very unwise it is to cover the interior walls of buildings with highly-glazed cement, tiles, or varnished paper, either of which prevents this diffusion.

Passing from buildings upon the surface to mines sunk in the earth, the advantage of natural means of ventilation is largely lost, diffusion entirely, and artificial methods for a proper supply of air have to be resorted to. In a mine perfectly free from gaseous exhalations, in which the supply of air is only required to maintain the respiration of the men, and the combustion of the candles or oil used for lighting purposes, 6,000 feet per hour per man, passed through the shaft and galleries, would probably be sufficient to fulfil all conditions, provided this amount was made to pass uniformly to the extreme end of the workings, but such a state of things is never found ; and when such gaseous exhalations occur, the quantity of air must be increasd to such an extent as to dilute the escaping gases to a perfectly harmless point. As the quantity of these gases varies from time to time, the quantity of air supplied needs to be kept far in excess of ordinary requirements, in order to meet the exigencies of exceptional cases. Also the presence of the ingoing air must be considerable, in order to overcome the resistance which it meets in passing through the passages. The means usually employed to effect such a result are either fans, or furnaces placed in the up-cast shafts, to create an upward current. This part of the subject is, however, a little beyond the present purpose.

The gases found escaping from the coal in coal mines, as would naturally be expected from the chemical changes through which the coal has passed, and is at the present time slowly passing, are marsh gas, or light carburetted hydrogen or fire-damp, and carbonic acid gas. These are found mixed with variable small quantities of sulphuretted hydrogen, nitrogen, and oxygen. The marsh gas or fire-damp is by far the most important of these, amounting as it does to from 75 to 95 per cent. of the escaping gas.

The following table gives the analysis of four samples of pit gas:—

	I. Barleith, Ayrshire.	II. Hepburn, Newcastle.	III. Llwynypia, S. Wales.	IV. Dunraven, S. Wales.
Marsh gas, CH_4	75·86	85·22	94·78	97·65
Olefiant gas, C_2H_4	..	trace.	..	..
Hydride of ethyl, C_2H_5H......	..	..	·90	..
Carbonic acid, CO_2	1·31	3·27	0·72	0·50
Carbonic oxide, CO..........	..	1·36	..	..
Nitrogen, N....	22·83	7·98	3·60	1·85
Oxygen, O	..	2·17	..	..
	100	100	100	100

These gases escape directly from the face of the coal, also through fissures which communicate with hollow spaces containing pent-up gases, which may cover large areas, and which, as has been previously pointed out, empty themselves into the mine until an equilibrium of pressure is established; also, though more occasionally, the gas issues from the floor or roof of the coal; apart from the occurrence of such liberated compressed gas, the coal contains within itself a quantity which has been absorbed or occluded; this occluded gas, so long as the coal is out of contact of air, and under an uniform pressure, will remain within it; but, on exposure, the tendency is for the larger part of the occluded gas to diffuse out into the atmosphere, at the same time an absorption of atmospheric oxygen and nitrogen takes place. The composition of the gas so contained within the coal is of very much the same nature as that issuing from undoubted reservoirs of compressed gas near the same district, a fact which would rather tend to indicate that it is not a case of true occlusion, but that the gas is held compressed within the interstices of the coal, as true occlusion would be selective rather than general, each gas being condensed in a different proportion to the others.

The amount of gas contained in this way is a very variable amount. Some coals are found to give off very little marsh gas, but more carbonic acid, while in others the marsh gas is more plentiful. Accordingly we have the difference between fiery coals and non-fiery coals. The coals which contain the least amount of condensed gases are the bituminous coals, in some specimens of which won from near the surface, no marsh gas is to be found at all. The greatest amount of condensed gas is obtained from the anthracite coal from a considerable depth. The following table represents a few of many analyses of such gases made recently in the course of a valuable investigation of the subject by Mr. J. W. Thomas (see next column).

The results represent the total volumes of gas obtained, in many cases after several times heating, and, moreover, after the coal had been some time out of the mine, but the amounts given off under the circumstances would be nearly proportional to the above, so that the relation of the coals in this respect would remain the same.

Analysis of the Gases evolved from 100 *grammes of Coal heated to* 100° *C. in vacuo.*

Sample.	Total Volume of Gas evolved in Cubic Centimetres.	Composition of Gas per Cent.			
		Carbonic Acid.	Oxygen	Marsh Gas.	Nitrogen.
Merthyr coal—Bituminous	55·9	36·42	0·80	—	62·78
Rhondda coal—Semi-bituminous.	73·6	12·34	0·64	72·51	14·51
Aberdare coal—Steam..........	250·1	13·21	0·49	81·64	4·66
Pembroke coal—Anthracite......	555·5	2·62	—	93·13	4.25

Mr. Thomas points out, in relation to this matter, that in the South Wales district seams of bituminous coals are continually worked in safety with naked lights, while the seams of steam and anthracite coals are of a much more dangerous nature; also the character of the coal, whether compact or porous, will largely influence the evolution of gas; thus the steam coals, although containing less condensed gas, being more porous than the anthracite, the gas escapes from the former in much greater abundance than from the latter.

Looking at the successive changes through which the woody fibre has passed, in its conversion into coal, in the light of the above fact, it would appear that in the earlier stages the formation of carbonic acid and water was the principal action, while in the later stages the formation of a greater amount of marsh gas occurred.

The quantity of gas issuing into a mine from the coal itself is dependent upon the extent of fresh surface which is from time to time exposed, and this quantity is found to vary according to the nature of the coal and the depth below the surface. The effect of the exposure of fresh coal surfaces upon the amount of gas issuing into a pit, is well illustrated by the remarkably rapid falling off in the amount of fire-damp which occurs when the coal is not being worked; but, in addition to this source of gas, which is tolerably constant, there is the further source in the issue of gas from fissures and hollow spaces, forming what are termed "blowers;" the amount of such gas is obviously likely to be very variable, and admits of little or no calculation, but it is found that its composition is approximately the same as that of the gas condensed within the coal of the seam from which such blowers proceed. The following analysis, also by Mr. Thomas, exhibits this fact (see next page).

In many cases, in addition to the marsh gas, small traces of a more condensed hydrocarbon are obtained, which makes the marsh gas burn with a slightly more luminous flame than the pure gas would do; probably this hydrocarbon is hydride of ethyl, C_2H_5H. The amount of gas escaping directly from the substance of the coal is, as has been already mentioned, approximately constant, and the necessary calculations for the proper ventilation of the mine under ordinary circumstances may be made; the fire-damp, to be safe, requires to be diluted

Sample.		Composition of Gas.			
		Marsh gas.	Carbonic acid.	Oxygen.	Nitrogen.
I. Dunraven Colliery 6 feet seam, 225 yards below surface	Blower	97·65	0·50	—	1·85
II. Same place	Boring	97·31	0.38	—	2·31
III. Pit in Rhondda district, 8 yds. from surface ..	Blower	95·47	0·62	—	3·91
IV. Pit Merthyr district, 9 ft. seam, 454 yards below surface	Boring	97·37	0·42	—	2·21

with at least from 30 to 40 times its volume (mines with less than $\frac{1}{40}$ of fire-damp in the air may be considered safe) of air, and no less than this amount must be provided wherever the gas issues. It must be remembered that an air current once vitiated cannot be purified, but can only be diluted. The gas coming from "blowers," on the other hand, is quite uncertain. A fissure containing gas may be tapped at any moment, by a stroke of a pick of a workman, or through the movement of the coal, and the gas that forthwith issues may do so with great rapidity, or more slowly, according to the difference of pressure, and it may be exhausted very speedily, or may continue to give off gas for long periods, sometimes even for years. There is especial danger when, in the process of removing the coal, "faults," or breaks, in the strata are arrived at, as under these circumstances there are to be found, generally, in the neighbourhood of such "faults," large hollow spaces, which are usually full of gas. Practical workmen state that occasionally a space within a mine, normally perfectly free from fire-damp, may, within less than two minutes, become full of explosive gas. On sinking a shaft at Whitehaven, in 1733, at a depth of 42 fathoms, a considerable amount of fire-damp was set free, a tube was carried from the pit, from the top of which the gas was burnt continuously for more than two years, the flame being some yards high. A jet of this gas was evolved at Wallsend, which likewise continued burning for some years, giving off the gas at the rate of 120 cubic feet per minute. In some cases, which are somewhat rare, the irruption of a blower into a mine takes place with considerable violence. The following is a description of the issue of a blower into a colliery adjacent to that of Lundhill, near Barnsley, Yorkshire :—"The fireclay floor of the seam was seen to heave at different points along the face, and presently large fractures were made in it, through which gas was ejected with great violence, and with a sound similar to the issue of steam from a high-pressure boiler." Sometimes, when the coal between a large fissure and the seam becomes thin by working, the intervening wall gives way, at other times the issue of gas will be accompanied with a noise, as of the explosion of artillery; the pressure under such circumstances must be very considerable. Subsequent to an explosion at the before-mentioned Lundhill Colliery, the pent-up gas, still issuing into the mine in the higher parts of the workings, supported two columns of water 30 ft. high, one 10 ft. and the other 11½ ft. in diameter, corresponding to about 11 lbs. pressure per square inch. When such large volumes of gas issue suddenly into a mine, even supposing that an explosion is prevented, the ventilation of the pit will be seriously and sometimes fatally interfered with. At the Tyne Main Colliery a blower suddenly broke out in the floor of the mine, which is stated to have given out from 6,000 to 7,000 cubic feet of marsh gas per minute, and which continued for 12 months before it ceased. At the Oaks Colliery, near Barnsley, after an explosion, the amount of gas passing out of the mine averaged 600 cubic feet per minute. At one time, at Wallsend, near the church, about four acres of fiery coal were worked at a depth of 150 fathoms, and they were drained by a 4-inch gas pipe, which was carried to the surface and there ignited, a flame of from 8 to 9 feet being produced, which roared like a furnace; not less than eleven thousand hogsheads of gas per minute formed the average supply collected in this imperfect way from the four acres of coal.

In the mines of South Wales, Mr. William Galloway, one of her Majesty's inspectors has kindly calculated for me the amount of gas escaping from one of the pits in a given time, and states that it is of a heating value of about one-tenth that of the coal won from the same spot.

The gas ordinarily issuing from the partly exposed face of the coal produces a slight hissing sound, particularly if the surface be wet; this is called by the miners "singing coal."

MISCELLANEOUS.

THE EXTIRPATION OF INSECTS INJURIOUS TO FIELD AND GARDEN PRODUCE.

The subject of the extirpation of insects injurious to field or garden crops has of late occupied considerable attention. No person was better qualified to deal with this matter than the late Mr. Andrew Murray, who brought it prominently before the Society in the form of a paper, read at a special meeting held on the 5th June last, which, together with the discussion, is printed in the *Journal* for June 8th, 1877, vol. xxv., p. 734. In the spring of last year also, two or three prominent entomologists had printed for gratuitous circulation a small illustrated pamphlet, under the title of "Notes of Observations of Injurious Insects." This gave instructions for observers to note the abundance or otherwise of any well-known insect pest, and invited remarks on any other points which might be of interest or value. The report on these inquiries has just been issued, and the result of this first year's experiment has quite satisfied the promoters, the inquiries having "been responded to far more cordially than could have been expected. Observers, both scientific and practical, have come forward to give the benefit of their experience." To what-

ever extent each person contributes his experience on this important question, so does he assist more or less in distinguishing the great yearly loss of food products from the attacks of insect pests, and consequently is doing a good service to the country and his fellow-men. It is shown in the report how much may be gained by continuing the observations for the time which would be requisite to form fairly complete notes of treatment found successful generally, with the modifications required by each year's peculiar weather, or by soils and climates varying as widely as the range from Banff to South Devon. As an illustration of the dangers of allowing crops of weeds to flourish in the immediate vicinity of cultivated fields, it is mentioned that at Knebworth, Herts, the surrounding weeds formed a means of support for the turnip fly until the crops were ready for attack. In North Lancashire, where vegetation was unusually backward, at the end of May the fly was likewise very injurious; and near Marlborough, where a great outburst in one locality came with the warmth of the latter weeks in June, a remedy was tried, which is described as having been very successful in previous years. The plan followed is to drive a large flock of sheep on the attacked field early in the morning, whilst the dew is still on the leaf, and with the help of a dog to keep them in constant motion, and well up in a body, so as to tread all over the field in turn. Treated in this way, no injury is done to the crop; but if much ground has to be gone over, it should be taken on different days, as it would injure the sheep to keep them long without food, or to harass them by the continued driving early in the morning. In this case, the extent of ground was 37 acres, and from 400 to 500 sheep were put on. The fly at the end of June was so strong as to threaten the clearance of the entire crop, and it had almost been decided to plough it up; but this treatment, which embodies disturbing and killing many of the insects by the treading, and which also makes the leaves distasteful for oviposition, both by the rubbing of the sheep and the coat of dust scattered in dry weather, saved the plants, and was followed by a good crop. The experience of the compiler of this report goes far to prove the efficacy of this treatment, for she says in her own garden near Isleworth, where the fly had been present, and sometimes very destructive during the last three years, she has found that simply sprinkling the young turnips with road dust preserved them entirely from injury. Some useful remedies are mentioned for the purpose of clearing the ground of their very common enemy, the wireworm; one is that of a solution of carbonate of soda in the proportion of about two ounces to sixteen quarts of water, applied three or more times from the beginning of May to the beginning of June. This was found to be efficient. At Knebworth, the wireworm appeared during the year in considerable quantities, attacking the barley soon after dead fallow. The bulk of the field was drilled with Lawes' Turnip Manure, and on this the barley grew rapidly away from the wireworm, whilst on two pieces (each seven feet wide) left across the field without the manure more than half the plants were destroyed. This difference was observed on previous occasions. Some idea of the contents and value of this report may be gathered from these abstracts. It may be worth mentioning, for the benefit of those who are able or willing to assist in these observations, that any information will be furnished on application to the Rev. T. A. Preston, The Green, Marlborough; or E. A. Fitch, Esq., Maldon, Essex, who, as well as Mr. T. P. Newman, 32, Botolph-lane, Eastcheap, will also supply sheets prepared for recording the observations.

The revenue of the Suez Canal Company in January this year amounted to £114,000, as compared with £112,600 in January, 1877. This result was obtained with a reduction of about 4 per cent. in the transit dues collected upon each ton of shipping passing through the canal.

PARIS EXHIBITION.

[FROM A CORRESPONDENT.]

Having spent much time in the Exhibition buildings and grounds lately, I am enabled to report with exactitude the actual state of affairs. I will premise my remarks by saying that anyone unaccustomed to exhibitions and extensive buildings or other works paying a visit to the Champ de Mars or the Trocadéro, and especially in such weather as that of last week, when the rain was almost constant, would never believe that the doors could be opened on the first of May, so terrible is the mud and dirt, so fearful the apparent confusion, and so beyond all apparent hope the completion of the work. But, to those accustomed to great exhibitions, the effect, according to my judgment, must be very different. The approach to the main building, except by the chief entrance, that in the Avenue de la Bourdonnaye, Porte Rapp, where there is a covered way from the road into the building, is certainly enough to discourage any who are uninitiated in such matters, for the number of buildings that lie around, mostly, however, finished as regards rough work, the constant passing of railway trucks, waggons, and vehicles of all kinds, in what in a few weeks is to be a beautiful pleasure ground, the soaked condition of the earth, and the constant trampling of thousands of feet, combine to make a fearful chaos, and in the lower parts near the river almost impassable swamps. But a few dry days and a little sun will make a magical change.

The covered way, or Marquise, of Porte Rapp, already mentioned, deserves special notice as an instance of the provident care of the Commission. On each side of the entrance gates, are buildings, one containing the offices of the Commission, the others those of the jury, between these is a long iron arcade, with an upper floor which is to be covered, and to form a communication between the two buildings; from the arcade and at right angles to it, a broad roof, supported on pillars, and having wide wings, on brackets, leads to the door of the building. The way thus covered cannot be much less than 100 ft. wide.

The grounds on this side of the building are full of interest, including all the annexes of the French section, appertaining to machinery, erected by the directors of Creusot, Terre-Noir, and other large establishments, and on the margin, in continuation of the commission and jury buildings mentioned, general annexes stretch the whole of the rest of the length of the Champ de Mars. The agricultural machinery building, which forms a portion, is one of the largest and lightest wooden structures of the kind I have seen, being supported by light trellis girders, in the form of pairs of cantilivres, rising from the floor and meeting under the ridge, while throughout the whole length of the building is a range of cast-iron standards, all ready to receive the bearings of driving shafts for giving motion to thrashing and other machinery. I must defer further description of the various buildings hereabouts to another opportunity, but it will be well to say that descending towards the river and taking the left hand, that is to say, in front of the great building, we arrive at the principal horticultural establishment, which consists of five or six and twenty glass houses, the foundations of all of which, and the superstructures of several, are finished or in process, with numerous kiosques and other special buildings, and in the midst a handsome chalet for a restaurant—every section of the Exhibition has its restaurant, café, brasserie, or buffet. Further on, towards the river, are the great buildings to contain the marine group, the ports of France, and other special and important collections, all finished or very nearly so; and still further, on the banks of the river, approached by steps form the quay, the great marine aquarium,

with its oyster parks, seal tank, and artificial river. Turning to the right instead of the left, we find half the Quay d'Orsay covered with well constructed, lofty, broad, wooden structures, for the exhibition of agricultural produce, in a double row, reaching all the way from the Champ de Mars and the Pont de l'Alma, a distance of twelve hundred feet or more. Nor is this the limit of the Exhibition, for passing along the same quay still further, we find two-thirds of the grand esplanade of the Invalides covered with large sheds for the various cattle exhibitions, six deep throughout the whole length, and all ready for use.

Here too may be noted another important work which is in progress, and will shortly be finished—a tramway, which will complete the line of communication between the Champ de Mars and the Place de la Bastille; and this naturally brings to mind the other special means of conveyance provided, or to be provided for visitors to the Exhibition. Last week, the branch railway from the Grenelle station to the Champ de Mars was opened, and I availed myself of one of the first day's trains; at present they leave the station of the Chemin de Fer de l'Ouest, Rue Saint Lazare, once an hour, from nine till six, but shortly they will run much more frequently; the journey occupies little more than forty minutes, and the charge is a franc for first, and half a franc for second-class tickets. In a short time the same railway will have a branch from its station at Passy almost to the door of the Trocadéro building. A tramway already runs from the centre of Paris past the foot of the Trocadéro, in the sunken road which now diverts the traffic from the quay, and which is so broad and gradually inclined that it has no appearance of being anything but an ordinary road; over it is a handsome iron bridge, which, with the Pont de Jena, forms the connection between the Trocadéro and the Champ de Mars.

The platform which covers and greatly widens the last-named bridge is finished, except the steps at each end. Finally, a large new landing-stage has been constructed on piles close to the Champ de Mars, for the accommodation of a whole flight of *mouches*, steam fly-boats, which are already plying on the river. Add to these the omnibuses and other public carriages, and the means of arriving at and getting from the Exhibition certainly promise to be tolerably complete.

Amongst the special exhibits I may mention one which is being prepared by the side of the landing-stage in question; it is a model—full-sized, I believe—of a sewer constructed on a new plan, but concerning which no particulars are yet published. There is no doubt that the sewage question will receive other illustrations during the Exhibition, for I am extremely sorry to learn that all the praiseworthy efforts of the Paris authorities, and of the engineers of *ponts et chaussées* who have conducted the experiments at Cluny, and the service of sewage to the market-gardeners' district on the Plaines de Gennevilliers, have not succeeded in applying the sewage to the ground. The quantity of sewage-water distributed on that arid plain has undermined several houses, and proprietors have sued for and recovered damages from the city in consequence; the authorities have, therefore, determined to construct an immense double culvert, ending in a deep basin, in which the solid matters in the sewage is to be precipitated, when the purified water will be let into the river, and the solid manure carted away to the plains. The authorities have long ago proved that none of the methods of precipitation yet tried can be made to defray expenses, but they have wisely laid it down as a positive law that the public health demands that the purification shall be effected *coûte que coûte!*

To return to the Exhibition proper. Approaching the building by the front, I note the façade decorated with illuminated shields of the exhibiting nations, which are to be surmounted each by its own colours; above the arch of the great door will be a device indicative of the French Republic, peace and prosperity; the great wrought iron pillars are being filled in with slabs of brilliantly coloured *faïence*, and on pedestals below a series of fine colossal figures are being set up, and are very effective.

Entering the grand vestibule, the first thing, perhaps, that will strike most people is the novel kind of decoration that has been adopted. All attempt, or nearly all, at treating the building as an iron one, has been abandoned; the ceiling is filled in with composition casts, those in the centre being circular, and of immense size, probably thirty feet in diameter, in strong wooden frames, and when on the floor, no one would have guessed that they were intended to be fixed overhead; their weight must be enormous. On each side of the preceding are three ranges of panels, and outside these again are decorative covings; the ornament is principally in dusky gold, with reddish brown reflections, and in the covings a little vermilion is introduced; the other colours are generally of a neutral character. The clerestory windows are peculiar, each being divided into nine equal parts, and the frames so planned that there is a square in the middle of each division, while all the rest of the bars are set obliquely, producing a number of triangular panes around the central squares, and beyond the former a number of squares set lozenge fashion.

A few of the panes are decorated with white scroll work on a blue ground stencilled on, and the remainder are rendered opaque. The effect does not strike one as very satisfactory, but the plan is a good one, and might be made to produce admirable results without much expense. The huge wrought iron pillars which support the roof, sufficiently large to contain fixed ladders, by means of which the top of the building is reached, are treated as metal, painted and heightened with bronze powder on the rivet heads and other prominent parts, but they are fitted with panels formed of plaster casts, painted and gilt, and over these with gilt medallions bearing the letters "R. F."—*République Française.*

Remembering that this noble vestibule was intended to be the grand promenade of the Exhibition, graced only with some of the most exquisite productions of Europe and Asia, it was startling at first to find it more like an enormous carpenter's shop than anything else, with an army of men busy at work. From end to end, with the exception of the central part reserved for M. Linden's grand trophy of Belgian horticulture, the middle portion is being covered with large structures. Of these by far the most remarkable is the Indian temple, in which are to be exhibited your President's treasures, with some of those of H.R.H. the Princess of Wales, and a selection of the most beautiful objects of Indian manufacture attainable. The pavilion was designed and is being erected under the eye of Mr. C. Purdon Clarke, the official agent for the Indian section; it is a compound structure, consisting of two pavilions, each having an upper floor, and connected by a long narrow arcade-like structure. The whole is formed of extremely slender and elegant colonettes set wide apart, the spaces to be filled in with plate-glass on all sides; along the central part is a frieze formed of open-work panels, and over each pavilion is a complication roof with several small domes surmounted with spikes. The structure is one hundred and thirty feet long and about thirty in width and height. It is much admired. It is being painted a bright chocolate colour, relieved with a little gold; other colours were tried experimentally, but this was considered the most successful. Just beyond this temple is a third pavilion, precisely like the other two; this is being constructed for the Colonial Commissions conjointly, to contain a selection of the most remarkable productions of our other possessions abroad. Canada, in addition, is erecting a large trophy of her own in the angle beyond, facing the machinery court.

In the French half of the vestibule several large timber structures are in hand, one being, I believe, for the State jewels. At the end is a remarkable grand pedestal in the Byzantine style, which is to support an equestrian statue of the Emperor Charlemagne. The pedestal has a solid base, and above this it is arcaded with coupled columns, surmounted with a socle, on which are represented the ornaments that formerly figured on the crown of the monarch, altogether a novel design well worked out. The emperor wears his crown and imperial mantle, holding his sceptre in hand, and is attended by two warriors. The group was modelled by an eminent artist, M. Rochet, who did not live to see it cast. It is in bronze, weighs nearly twenty-five tons, and was erected by M. Thiébauld, of Paris.

From the place of this noble group the eye takes in the whole length of the French machinery court, the largest ever devoted to such a purpose; the amount of work to be done here within the next few days is enormous, but by the first of May it will, I doubt not, present a pretty complete appearance; at present more than one large driving engines are ready for work, and a large number of heavy castings and pieces of machinery are rapidly being got into place. Even this enormous gallery will not contain half the machinery and metal work shown by France, for parallel with it is an annexe of the same length for machinery and apparatus not in motion, in which platforms on both sides and down the middle are all ready to receive them, besides all the buildings in the grounds mentioned above.

From the other end of the vestibule is seen the corresponding foreign machine court, the British section at the head, and forming about one-third of the whole. The most conspicuous objects at present are a large horizontal compound engine by Messrs. Galloway—who have their boilers outside—and a large space being covered with lead, and otherwise prepared for Messrs. Platt Brothers and Co.'s spinning machinery. But every day tells, and, with the aid of one of Messrs. Appleby's steam cranes, on rails at the side, huge loads are dropped into place with great celerity. England has also immense machinery and implement annexes outside, all ready, and which will be all full before another ten days have passed.

In the triple industrial courts, all the Commissions seem to be progressing admirably; it has been stated by French authorities, that the British section is the most advanced, and there is no doubt that all will be ready in capital time. Already in the textile, ceramic, and other classes, a great number of large and handsome cases are in place, and an interesting scene occurred the other day, when Messrs. Adams and Bromley, of Hanley, filled their case with a fine collection of decorative ware of various kinds, and some French workmen who had been employed by the firm, presented Mr. Adams with a pot of handsome flowers, with a label bearing the following inscription :—"Bonheur, honneur et homage au premier exposant; offert par la France. Vive l'Angleterre: Vive la France!"

I feel pleasure in adding on my own testimony that the French industrial courts are in a most promising condition; long lines of handsome cases, including those of the Lyons, St. Etienne, and other textile centres, are completely finished and inscribed with the names of the various towns, the woodwork of many courts is done, and that of many more proceeding rapidly, velums and screens are in place, and a portion of exceeding elegant drapery, specially designed for the decoration of the ends of these three galleries, where they are cut by transepts, was put up some days since. Speaking of velums, I should mention that the British Commission has adopted a material similar to that used in 1867, an unbleached cotton with British and Indian symbols, printed in pale gold colour, distributed over the surface, while other Commissions generally adopt plain white. The former is preferable in my opinion.

Canada covers a large space in the industrial courts with very handsome cases, generally uniform, constructed of light and dark woods of the country, and exhibiting good taste and workmanship.

Other foreign sections are in a highly satisfactory state, but I must defer at present speaking of more than one—namely, China, which has the most ornate and largest cases in the Exhibition, together with a grand portal which forms the main entrance to her court. These cases, more than twenty in number, are composed of pillars, with elaborate roofs like temples, formed of woods of many colours, and decorated with carving and pierced work of the most varied and elaborate kind, gilding, and colour. No two, I think, are alike, either in form or ornamentation, and altogether they are marvels of ingenuity. The Chinese buildings on the Trocadéro, too, are on a large scale, and promise to be highly attractive. I may just add that the Japanese are finishing off a small elaborately decorated court close to the Chinese.

The works proceeding and executed in other parts of the Champ de Mars and on the Trocadéro are almost innumerable, and many of them highly interesting, but I cannot enter upon them to-day.

The great question of free admission, or low charges on Sundays, has been much discussed, and is settled in the following manner: the price of tickets is to be the same as on other days, that is, one franc during the first two months, half a franc during the two next months, and four sous afterwards. Many persons believe that a uniform charge of four sous would have brought more money to the exchequer, besides being enormously popular.

Amongst the special exhibitions included in the vast plan is one for workmen's productions exclusively, which is to be held in a building in the grounds, measuring 42 metres by 13, with two annexes 15 metres long, with a piece of ground for gardeners. The Municipal Council has contributed 50,000 frs., and the General Council of the Seine 20,000 frs., to meet expenses. Nothing protected by patent or otherwise will be admitted.

The Chamber of Deputies has voted a considerable sum, to enable the President of the Republic and high officials to *fête* their guests from abroad in a worthy manner without heavy charge to themselves. The vote was preceded by another which deserves special notice; it grants to all *employés* under Government receiving less than 2,400 francs per year an addition of 10 per cent. to their salaries during the time of the Exhibition: this amounts to nearly a million of francs. The other votes are half a million to the President, a quarter of a million each to the Ministers of Agriculture and Commerce, and of Foreign Affairs, 150,000 francs to the Minister of the Interior, and 100,000 to each of the other Ministers, making, in all, a total of 2,722,500 francs; and half a million has been voted besides to the Minister of Agriculture and Commerce, for the cost of travelling of agriculturists and workmen sent up by the departments to study the Exhibition.

The City authorities will also give entertainments at the Luxembourg, which is being decorated for the occasion.

It will be well, perhaps, to add that there are entrances on all sides of the Exhibition, 16 in number, several having three or four gates; and that ordinary tickets of admission will be procurable, not only at all post and telegraph offices, and tobacconists, but at omnibus and other stations, and at kiosques, specially placed for the purpose near all the entrances of the Exhibition on both sides of the river.

The annual report of the Director of the National Gallery for the year 1877 has just been issued. The galleries were visited by 1,332,794 persons on the public days during the year, showing a daily average of 7,014. The collections received, on students' days, 20,313 visits from students.

CORRESPONDENCE.

DEPRECIATION OF SILVER CURRENCY.

You will perhaps favour me with permission to add a few words in reply to the interpellations on my remarks that have been made by Colonel Smith, a gentleman who is at once so courteous and fair in debate that it goes rather against the grain to differ from him.

The omission on my part to introduce the element of seigniorage into the calculations I offered as to the gold value of the rupee, has not arisen, as Colonel Smith attributes it, from accident, but from design.

I do not think that India could act differently from any other country if it were to chango its single standard of silver into a single standard of gold. And no other country thus resorting to the gold standard has found it politic or expedient to charge the heavy seigniorage on bullion which is still imposed in India by the mint regulations of that country.

Were India to adopt a single gold standard, she would be obliged to forego any seigniorage on gold bullion, and would have to substitute for it a mint charge not much, if at all, greater than the one in use in European countries. This abandonment of a sovereign and ancient right to seigniorage on coinage, which she inherits from the former rulers of the soil, would arise, not from there being anything intrinsically wrong in a principle that will be found sanctioned by all the codes of antiquity, but simply from the necessity that India, if she does undertake a coinage reform in present times, must modernise her practice, and put herself on a line of equality with what is done by other nations. Any contrary course would be to hamper the importation of the precious metals with a charge that has been abandoned elsewhere as unsuited to the spirit of the age.

Colonel Smith's contention is, that my omission of the element seigniorage supposes that I was not aware that the seigniorage on silver bullion at Calcutta was 2 per cent. plus extra charges, at Madras 3 per cent., and at Bombay "4 per cent. without extra charges." I beg to assure my gallant friend that I was aware that the Calcutta mint charged 2 per cent., but that it is news to me that the Bombay mint charged 4 per cent., as its printed rule in my possesion, dated 1875, and numbered 9, is as follows:—"9. The seigniorage on gold bullion or coin shall be at 1 per cent. of the standard value. The seigniorage on Sicca rupees shall be 1 per cent. There shall be no seigniorage on short-weight Madras, Furruckabad, and Government rupees. The seigniorage on all other descriptions of silver coins and bullion shall be 2 per cent."

It matters nothing, from my point of view, whether the coinage of silver bullion into legal tender coin was charged with a different rate of seigniorage from that on coinage of gold bullion into coin that was not legal tender. I only recognise the fact that in the exercise of a sovereign right the Government of India did charge a seigniorage on its sole and legal tender coinage standard of silver. Now, had gold been the legal tender coinage, and gold the single standard of value in India, there can be no manner of doubt that her Government could and would have imposed a seigniorage, probably and presumedly of the same per-centage as they continued to do on silver bullion, from 1835 down to the present time. To use the non-scientific language for which your correspondent, Lord Borthwick, contends in his letter in your last number, what is "sauce for the goose is sauce for the gander;" so that, when Col. Smith contends for my having, in error, left out seigniorage from my equivalent value in gold of silver coin, he forgets that the same seigniorage would be an element in getting at the equivalent value in silver of gold coin.

Col. Smith then goes on to say that I have omitted to reckon the freight of the bullion which, in 1835, went round the Cape of Good Hope, a four months' voyage; also the cost of insurance, the loss of interest, and the coinage charges. Here, again, I assert there is an entirely useless complication of the question. For whether such expenses on silver bullion were 1 per cent. or any other rate, similar expenses would alike have applied to the importation of gold bullion into the Indian mints for the purposes of coinage. And, to repeat my thesis. the same quantity would appear on both sides the equation, and would thus leave the ratio between gold and silver unaffected.

It is only to-day that I have had the opportunity of procuring the work just published, written by Mr. Rowland Hamilton, a gentleman who took part in some of the former discussions at this Society on the question of a gold currency for India. I see that so far from coming to the conclusion of Colonel Smith, that 2s. per rupee is the gold price of the rupee, Mr. Hamilton comes very near to my own calculation that such a valne as that can only be exact if Colonel Smith can show that the price of silver was $64\frac{9}{16}$d., or a little over 5s. $4\frac{1}{2}$d. per ounce. I will quote a few lines from page 373 of this book by Mr. Hamilton on "Money and Valne, the Depreciation of Silver, &c. Macmillan, 1878." "In fact, the silver (183·861 grains) required to make a rupee is not itself worth 2s. in England unless the price of 5s. $3\frac{1}{4}$d. per ounce can be obtained, and the coin itself would not come out at that rate except at a price over 5s. $4\frac{1}{2}$d. per ounce British standard. No such price ever was paid, though notwithstanding this, the rate of exchange was often very much over 2s. per rupee. The charges of transit should, in fact, be omitted as altogether irrelevant in fixing the relative values of the two metals at the same place, or at least charged on both equally."

I must, in conclusion, call notice that, by a typographical error, the decimal point in the second paragraph of my observations (page 437 of *Journal*) has got displaced. The words "gold rupee would contain 113·0016 grains of pure gold," quote the weight incorrectly. It should be 11·30016 grains.

Frederick Hendriks.

15th April, 1878.

INDIAN COMMERCIAL PRODUCTS.

I have perused with great interest various letters in your *Journal*, from Mr. Thomas Routledge, on bamboo as a paper stock.

From my knowledge of British Burmah, having been one of the pioneers of its commerce, I am convinced that bamboo can be obtained to any extent required from the boundless jungles of its several provinces, most accessible also for cutting and conveyance to a central depôt, or to a port, by means of the numerous rivers that intersect the land. The climate, with its abundant rainfall, seems also to point out this country, particularly the "Tennassaram Provinces," of all tropical lands, as the very one for carrying on the operations proposed by Mr. Routledge.

The young shoot, the part of the plant required for fibrous stock-making, can be cut from October to December, growing, as it does, from thirty to forty feet during the rainy season; say May to October. Mr. Routledge speaks of obtaining by irrigation a continuous crop of young shoots, and mentions some interesting results obtained by Mr. Thomson in Jamaica; should the laying down of plantations be thought desirable, there are plenty of sites admirably suited for such, but I am of opinion that the ever-recurring young shoots, round the unlimitable supply of parent stems, should be ample for the requirements of paper makers for, at any rate, some time to come. R. Spear Begbie.

Junior Carlton Club, April 4th, 1878.

HEATING GAS.

In relation to Mr. S. W. Davies's paper on "Heating Gas, &c.," read on Wednesday, the 10th inst., I find some errors in the report of my remarks. I am said to "differ from Sir Francis Knowles." I am not aware that I did. I think I only expressed gratification at the apt division, by Sir Francis, of heating gases into "wet" and "dry." Passing over some points as unimportant, I come to the following—"theory taught that you ought to get from a pound of carbon over 2,000 cubic feet." For "pound" read "ton," and for "over 2,000" read "nearly 200,000." Again I could easily understand that under higher working pressures a larger volume of gas per pound of carbon could be produced, but could not understand why, if "more perfect combustion" ensued, the produced gas should not contain a greater per-centage of nitrogen, and of CO_2. "Incandescence," instead of "ignition," is the proper word in my last observation. F. W. Hartley.

Millbank-street, S.W., April 15, 1878.

PLAGUE OF MICE.

Sir,—I do not at all doubt that Mr. John Colebrook quotes the "Treasury of Zoology" correctly, but it seems to me that that work is in error in describing the genette (*Genetta vulgaris*) as a member of the "weasel tribe." In Cassell's "Natural History," edited by Professor Martin Duncan, the genette is rightly referred to the Civet family, *Viverridæ*, to which it unquestionably belongs. I shall be obliged if you will kindly insert this note for the benefit of your readers.

J. A. M.

GENERAL NOTES.

Bethnal-green Branch Museum.—The Lords of the Committee of Council on Education have directed that a special loan exhibition of furniture, cabinet work, and ornamental woodwork used in the interior of dwellings, shall be held in the Bethnal-green Museum during the summer months, commencing on 1st May. This will occupy the space rendered available on the ground floor of the museum by the removal to Paris of the Prince of Wales' Indian presents, till lately shown there. Their Lordships understand that the manufacture of household furniture is largely carried on in the East of London; hence they believe that the proposed Exhibition will be of special interest in that district. Her Majesty the Queen has been graciously pleased to direct that a selection from the furniture of the Royal palaces shall be included in this Exhibition.

Japanese Archæological Society.—Japan possesses an archæological society which exhibits great activity. Its title is equivalent to "Society of Antiquities." Its members number two hundred, and are distributed over the country, meeting once a month at Jeddo. They consist of rich men, savants and priests, the last-named having access to great stores of curiosities hidden in the temples or preserved in families. M. H. Von Siebold, *attaché* to the Austrian embassy at Jeddo, is a member of the society, and has published recently a guide for the systematic study of Japanese archæology. The same gentleman has recently made the extremely interesting discovery at a place near Jeddo, of a mound containing more than five thousand objects in stone, bronze, &c., of prehistoric times. In a recent communication to the Anthropological Society of Berlin, M. Von Siebold describes the origin of the earthen figures found in ancient Japanese tombs; it appears that until about the commencement of the Christian era, it was the practice to inter alive around the body of an emperor or empress a number of their servants, so that their heads formed a horrible coronal around the regal corpse. When this barbarous practice was given up, the earthen figures were adopted in place of the human heads.—*Moniteur des Arts.*

NOTICES.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at eight o'clock.

April 24.—*No Meeting.*

May 1.—"The Reforms in House Construction Demanded by Sanitary Science." By John Balburnie, Esq., M.A., M.D.

May 15.—"Dietaries, in their Physiological, Practical, and Economic Aspects." By R. M. Gover, Esq., M.R.C.P., Lond.

May 22.—"Controlling and Connecting Clocks by Electricity." By Frederick J. Ritchie, Esq.

African Section.

Tuesday evenings, at Eight o'clock.

April 30.—"The Progress of Agriculture and Stock Farming in the Colony of Natal." By Peter C. Sutherland, Esq., M.D., Surveyor-General of the Colony. The chair will be taken by J. A. Froude, Esq.

May 28.—"A Year on the Nyassa, with Notes on the Slave Trade, and on the Prospects and Means of Opening up the Surrounding Country." By H. B. Cotterill, Esq.

Chemical Section.

Thursday evenings at eight o'clock.

April 25.—"The Purification of Water by Filtration." By Gustav Bischof, Esq., F.C.S.

May 9.—"Some Recent Improvements connected with Alkali Manufacture." By James Mactear, Esq.

May 23.—"The Position of Chemistry in a System of Technical Education, as illustrated by some of its applications." By J. M. Thomson, Esq., F.C.S., of King's College, London.

Indian Section.

Friday evenings at eight o'clock.

May 3.—"The Telegraph Routes between England and India." By Major Bateman-Champain, R.E.

May 17.—"Agriculture in India." By F. C. Danvers, Esq.

MEETINGS FOR THE ENSUING WEEK.

Tues. ...Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Antiquaries, Burlington House, W., 2 p.m. Annual Meeting.

Wed. ...Royal Society of Literature, 4, St. Martin's-place, W.C., 4½ p.m. Annual Meeting.
London Institution, Finsbury-circus, E.C., 12 noon. Annual Meeting.

Thur. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Chemical Section.) Mr. G. Bischof, "The Purification of Water by Filtration."
Society for the Encouragement of the Fine Arts, 9, Conduit-street, W., 8 p.m. The Third Conversazione.
Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.

Fri.......Quekett Microscopical Club, University College, W.C., 8 p.m. Mr. J. G. Waller, "Variation in *Spongilla fluviatilis*."
Clinical, 53, Berners-street, W., 8½ p.m.

Sat.......Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,327. Vol. XXVI.

FRIDAY, APRIL 26, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

NATIONAL WATER SUPPLY.

Committee.—Major-Gen. F. C. Cotton, R.E., C.S.I. (Chairman of the Council), W. Hawes, F.G.S. (Deputy-Chairman of the Council), F. Abel, C.B., F.R.S., Alexander H. Brown, M.P., James Caird, C.B., E. Chadwick, C.B., Lord Alfred Churchill, Hyde Clarke, Sir H. Cole, K.C.B., Capt. Douglas Galton, C.B., F.R.S., Sir U. J. Kay-Shuttleworth, Bart., M.P., R. W. Mylne, F.R.S., F.G.S., Admiral Sir Erasmus Ommanney, C.B., F.R.S., Prof. Ramsay, F.R.S., F.G.S., R. Rawlinson, C.B., T. R. Tufnell.

The Congress will be held on Tuesday and Wednesday, 21st and 22nd May, 1878, at 11 o'clock.

The object of the Congress is to discuss the question of a comprehensive scheme of National Water Supply, "with a view to the consideration of how far the great natural resources of the kingdom might, by some large and comprehensive scheme of a national character, adapted to the varying specialities and wants of districts, be turned to account, for the benefit, not merely of a few centres of population, but for the advantage of the general body of the nation at large," as suggested in the letter of H.R.H. the Prince of Wales, President of the Society, in which the subject was first brought to the notice of the Council of the Society.

Papers, prepared at the request of the Council, will be printed and circulated at the Congress, and discussion will be taken upon them.

HEALTH AND SEWAGE OF TOWNS.

Executive Committee.—Major-General F. C. Cotton, R.E., C.S.I. (Chairman of the Council), W. Hawes, F.G.S. (Deputy-Chairman of the Council), F. A. Abel, F.R.S., Lord Alfred Churchill, Sir Henry Cole, K.C.B., Col. Sir E. Du Cane, K.C.B., Capt. Douglas Galton, C.B., F.R.S., T. W. Keates, Dr. Voelcker, F.R.S.

The Conference on this subject will be held on Thursday and Friday, 23rd and 24th May, 1878, the Right Hon. James Stansfeld, M.P., late President of the Local Government Board, in the chair.

Programme of Proceedings.

The Conference will meet each day at 11 a.m., and will sit till 1.30, then adjourn till 2, and sit again till 5 p.m., and if necessary, meet again at 8 p.m.

Thursday, 11 a.m.—Opening of the Proceedings by the Chairman. Papers and discussions on—

1st. Public Health as Affected by various Treatments of Sewage.

2nd. Gradual Abolition of Cesspools and Middens, and Substitution of Tubs and Pails with speedy removal.

3rd. Whether any further Legislation, of a Compulsory or Permissive Character, is needed for bringing about a better Sanitary Condition of Towns or Dwellings.

4th. Progress, if any, made in the Utilisation of Excreta since the last Conference.

5th. Progress, if any, made in Treating Water-carried Sewage since the last Congress.

6th. Escape of Sewage-gas into Dwellings, and Modes of Prevention.

7th. Discharge of Sewage into Sea.

8th. Cost of Systems given in the last Report of the Local Government Board.

Friday, 11 a.m.—Proceedings will be resumed.

Papers and discussions continued.

Papers on any of the above heads are requested.

The object of the Conference is to discuss existing information in connection with the results of the systems already adopted in various localities; to elicit further information thereon; and gather and publish, for the benefit of the public generally, the experience gained. The introduction and discussion of untried schemes will, therefore, not be permitted. Special papers, which have been prepared at the request of the Council, will be printed and circulated at the Conference.

There will be an Exhibition of Appliances connected with Sanitation and Water Supply. Manufacturers and others desiring to exhibit should communicate forthwith with the Secretary of the Society of Arts.

UNION OF INSTITUTIONS.

The following Institutions have been received into Union since the last announcement:—

Glasgow Association for the Higher Education of Women, 59, Bath-street, Glasgow.

St. Anne's, Wandsworth, Science and Art Classes.

CANTOR LECTURES.

Dr. Richardson has delivered two of the Cantor Lectures on the subject of "Putrefactive Changes in Animal Substances" and on "Preservation," and the lectures will be published in due course in the *Journal*. The first lecture, delivered on April 6th, gave a view of an historical kind on the subject in hand, and presented, in detail, the methods at present adopted for the process of embalming.

In the second lecture, delivered on April 15th, Dr. Richardson described the direction of his own researches since 1850, and explained the theory he has arrived at as to the immediate cause of decomposition of dead organic substances. His theory in this matter is, that the first step in the course of putrefaction consists in the decomposition of the water, contained in the animal substances, into its elementary parts, and in the oxidation which immediately follows the liberation of the nascent oxygen. In this change, as he showed by a number of experiments, the atmospheric oxygen need play no primary part. The cause of the decomposition of the water of the dead tissues is due to the presence of certain organic substances, of which the red colouring matter of the blood, and fibrine itself, are probable representatives. The same part may also be played by organic particles, conveyed to the dead structure by the air.

The practical deduction is, that every substance which fixes the water of the dead tissues, or which prevents the action of organic agents in promoting the decomposition of the water, is a true preserver, or antiseptic.

The lecture was illustrated throughout from specimens and by experiments.

ADDITIONAL LECTURES.

EXPLOSIONS IN COAL MINES.

By T. Wills, F.C.S.

Lecture II.—Delivered February 4th, 1878.

In my last lecture I referred to a calculation which had been kindly furnished me by Mr. W. Galloway, of Cardiff, regarding the heating value of the fire-damp escaping from a mine in South Wales; the figures of this calculation also exhibit the enormous pressure under which the condensed gas must be contained within the coal. In the particular pit referred to the upcast ventilating current equals 80,000 cubic feet of air per minute; one-fortieth of this, or 2,000 cubic feet, consists of marsh gas, or fire-damp. The amount of coal raised from this pit per day is, on the average, 1,000 tons. One ton of coal approximately equals one cubic yard. The amount of coal raised, however, is really less than the amount excavated, the difference being about one-fifth; this quantity being left in the mine. So that it may be considered that 1,250 cubic yards are excavated per day. Hence, from this, it would appear that the fire-damp escaping in the same time occupies a space 85·3 times that of the coal excavated. Suppose one-half, which would probably be in excess of the true amount, of this gas to come from other seams through fissures, and not from the seam immediately being worked, there will still be fire-damp issuing from the coal representing 42·6 times the volume of the coal removed. Now, to compress this gas back again into the space occupied by the coal would require a pressure of 639 lbs. per square inch; but, in reality, the coal and the fire-damp must be considered as having occupied the same space, hence the pressure would have to be indefinitely multiplied. The gas so escaping from mines with the ordinary ventilating current through the up-cast shaft is discharged directly into the atmosphere, and becomes diffused.

Nature and Properties of Fire-damp.

So far we have been speaking of the production and occurrence of marsh gas or fire-damp; it is necessary now to get some idea of its nature and properties. This substance forms the miner's most subtle and at the same time most disastrous enemy.

Marsh gas is the simplest compound of carbon and hydrogen; that one which contains the largest proportion of hydrogen in relation to the carbon; its chemical symbol is CH_4, which, giving to the C and H their respective numerical values, means that in every 16 parts by weight of the gas there are found 12 parts of carbon and four of hydrogen, *i.e.*, 75 per cent. of carbon and 25 per cent. of hydrogen. The gas is without colour, taste, or smell. Up to within the last month it has never appeared in any other form than that of a gas, but it is stated that M. Calletet, of Geneva, has succeeded in reducing it with certain other refractory gases to the liquid condition. In addition to its occurrence in coal mines, it is found in marshy places, arising in such cases from the decomposition of vegetable matter, from whence its name of marsh gas, also it issues in jets from certain parts of the earth's surface, and it is found as a general result of the imperfect combustion of carbonaceous fuel; it occurs as a constant constituent of coal gas, forming sometimes as much as 70 per cent. of the volume of such gas. The specific gravity of the gas is about one half that of air, being correctly 0·5576; this lightness forms one of its most dangerous properties, as it causes an accumulation of the gas in cavities and holes in the roof, places which are usually imperfectly ventilated.

Marsh gas is inflammable, burning with a bluish flame with a yellow tip; it is generally stated to give no light, but this is erroneous, although the amount of light emitted is very feeble. The gas does not support combustion, neither does it support life, yet it does not act as a direct poison upon the system, and if mixed with a fair proportion of air, may be breathed for some time without producing any deleterious effects; this is the case even if it be mixed with only its own volume of air; a mixture of air with 30 per cent. of marsh gas is quite breathable. Marsh gas requires a high temperature for its ignition, a very important consideration; a red heat will not ignite a jet of marsh gas, neither will it explode a mixture of marsh gas and air; a temperature between 1,000 and 1,500° F. is required for its inflammation supposing the gas to be pure, the mixture of other hydrocarbons causing it to ignite at a lower temperature. On the combustion of marsh gas taking place, either slowly or suddenly, the hydrogen burns to form water and the carbon to form carbonic acid gas; the volume of the carbonic acid so produced is equal to the original volume of the marsh gas, if measured at the same temperature; but in the case of an explosion of fire-damp the volume of the produced carbonic acid is considerably greater owing to the elevated temperature.

All inflammable gases, when mixed with certain

proportions of either air or oxygen, become explosive, and it is in this respect that the serious dangers connected with the presence of marsh gas occur. The theoretical amount of oxygen required for the complete combustion of marsh gas is readily calculated thus:—

$$\begin{array}{ccccccccc} & & & & \text{Steam.} & & \text{Carbonic acid gas.} \\ CH_4 & + & 4\,O & = & 2\,H_2O & + & CO_2. \\ 2 \text{ vols.} & + & 4 \text{ vols.} & = & 4 \text{ vols.} & + & 2 \text{ vols.} \end{array}$$

As air contains one-fifth of its volume of oxygen, 20 volumes of air would be required for the above combustion, *i.e.*, 1 volume of marsh gas and 10 volumes of air. If a mixture of this nature is ignited, combustion takes place almost at the same moment throughout the entire volume, and this sudden combustion is nothing more than an explosion. The calculated pressure produced by the explosion of marsh gas with oxygen is 37 atmospheres, or 555 lbs. upon the square inch. Since the explosion with air is rendered much less violent by the presence of the four-fifths of inert nitrogen, the pressure exerted is also much less, being only 14 atmospheres, or 210 lbs. per square inch. The above figures refer to the absolute theoretic quantities of marsh gas and air in oxygen, but there is a margin on each side, within which explosion still takes place, with, however, a diminished intensity; thus when 1 part of fire-damp is mixed with approximately about 30 of air, it can be recognised by a candle flame which will appear with a blue halo round it; if the fire-damp increases to 1 part to 15 of air, the mixture will still not explode; 1 part of fire-damp to 13 of air becomes slightly explosive; as the theoretical amount of 1 to 10 is reached, the explosion becomes more and more violent. The most violent explosion is stated to occur in practice, when the fire-damp is in the proportion of 1 part to 9·4 of air. When the limit of 1 to 10 is passed, the force of explosion will become less and less, until when there is 1 vol. of marsh gas to 5 of air, the mixture ceases to be explosive, but is simply inflammable; lighted flames go out on being introduced into such a mixture. These statements must not be accepted as applicable to all cases, as the differences in the character and composition of the fire-damp will materially alter the results. If carbonic acid gas be present at the time, it lessens the explosive force. One-seventh part of carbonic acid added to a perfectly explosive mixture prevents any explosion from taking place on the approach of a light; these facts refer to fire-damp itself, and if any other hydrocarbon be present in it, certain modifications within narrow limits occur.

It very rarely happens that in actual explosions of fire-damp the mixture of air and gas is precisely of the exact nature required for the maximum effect, and hence we have the very varying effects produced by explosions; were it not for the so-called after or choke-damp produced, explosions of fire-damp would be nothing like so disastrous as they are.

A very large number of explosions are continually taking place in collieries, only a small proportion of which, however, are attended with fatal results.

The following table, for the two years 1871-2, will illustrate this fact:—

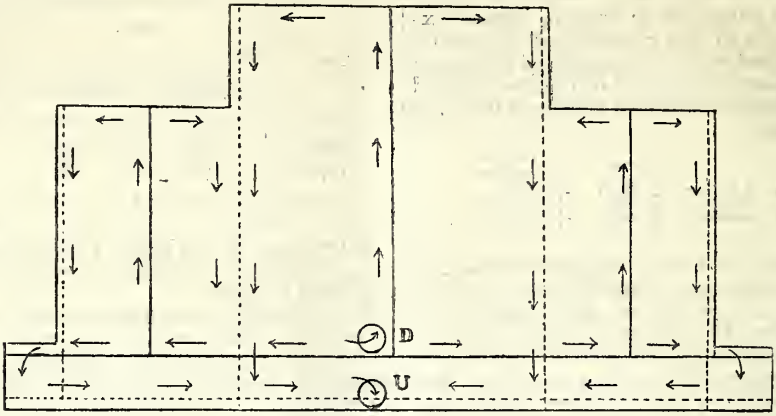
Year.	Fatal.		Non-fatal.
	No. of Explosions.	No. of Men killed.	No. of Explosions.
1871	52	268	234
1872	70	163	224

Let us now, in the light of these facts, look at the actual dangers arising from the presence of fire-damp in mines.

It is necessary in the first place that, in order to be worked at all, a system of ventilation shall be adapted to every mine, in order that the air required for the respiration of the men shall be forthcoming. The amount of air supplied must be such that the men furthest removed from the inlet shafts shall receive the requisite amount; and the air must also be increased to such an extent as to dilute and carry off the gases escaping from the face of the coal. The absolute quantities supplied to different mines will vary with the circumstances of the district. In some of the northern coal-pits 150,000 to 300,000 cubic feet of air per minute are passed through the workings; this draught of air may either be obtained by means of a furnace placed in the up-cast shaft, or by some form of fan placed at the top. In any case the air will descend the down-cast shaft, and it has then to be spread through the workings. This is accomplished by cutting off all direct air communication between the upcast and downcast shafts. In practice the plan adopted consists in a special arrangement of the roadways or drifts, as they are called; these being in reality galleries running from the base of the downcast shaft to the several faces of the coal, and from the termination of these drifts others are carried back to the base of the upcast shaft. If these two sections of the mine be perfectly isolated from each other, and the current of air be sufficient at all points, a thoroughly good system of ventilation is obtained. An ideal case would exist if a coal mine consisted of one long gallery, the sides and roof of which were smooth and regular, the downcast shaft being placed at one end and the upcast at the other. In actual practice, however, this is never the case, many drifts and galleries being worked which run into the main galleries, and which, with them, must be ventilated. To effect this the air is usually split into several streams shortly after it enters the mine, each of which travels separately from the others, these streams of air are carried to the various extreme points of the workings, where a junction is effected with a second series of galleries communicating with the upcast shaft, and which consequently form the return air courses.

A reference to the following typical plan of a mine will render the explanation clearer:—

D and U represent the downcast and upcast shafts of a mine respectively; the air descends the downcast shaft, and at the base is divided into three channels, these being again subdivided as circumstances require. The continuous lines represent these courses, and the arrows associated with the lines indicate the direction of the in-going air. When the air has arrived at the furthest part of



the working, it passes round the face of the coal, and then enters the return air courses which are represented by the dotted lines, the arrows again showing the direction of the air now on its way back to the upcast shaft, where it is necessary for the two streams to cross each other one of them is carried over or under as the case may be. It will readily be seen that, by a suitable arrangement of these drifts, a given volume of air can be carried to any part of the mine, and, at the same time, each section of the mine can be ventilated by its own special air current. In extensive workings, a system of this kind is the only satisfactory one, as no single air current should be made to travel over more than a limited area of such a mine.

For the ventilation to be effective, the air must not be permitted to take a short cut from the one system of galleries into the other, or some portion of the mine, or more distant workings, will remain in a state of stagnation. Now, as for the purpose of conveying the coals, and maintaining communication between the various parts of the mine, it is impossible to keep the two absolutely without connection, a series of doors are erected, which are usually kept shut, but can be opened for a short period for the purposes of passage. Upon the proper working of these doors depends largely the success of the ventilation. Brattice walls are also common, and are simply artificial wooden walls erected for the purpose of diverting the air current. Where the system here indicated is not adopted, the coal is usually removed entirely from the further part of the workings, and the roof is allowed to fall in and fill up the excavated places; such old workings are called goafs. These goafs are considerable sources of danger, owing to the facilities which they offer for the accumulation of fire-damp, which may remain for a time totally unsuspected. The neighbourhood of these places always requires careful watching, to detect the presence of fire-damp. The air under this system of ventilation has a simpler course, and is not dependent upon the proper closing of doors. One great source of danger, in either case, exists in the great irregularity of the form of the various passages; hollow spaces occur in the roof owing to a fall of the material; short unused passages are imperfectly stopped; differences in height and width occur dependent upon the requirements of the pit, all of which have considerable effect upon the ventilating current, and afford the circumstances for the collection of fire-damp. Now, an explosion may be produced in either one of the following ways:—

1. Supposing the fire-damp to be issuing from the face of the coal with tolerable regularity, so long as the proper current of air is maintained this is swept away in safety, but if, by a door being left open, or through an imperfect stopping, the air current partially or entirely takes a short cut, the face of the coal will be imperfectly freed from the gas, and an explosive atmosphere will gradually result; if miners enter this with naked lights, a disaster occurs of more or less gravity as the area of explosive gas is greater or less.

2. Gas is invariably found first in cavities in the roof and in the higher parts of the passages, and it is possible for an explosive atmosphere to be generated in the upper part of a gallery, while below the air is quite safe; if the gas is not dislodged, the limit of the stratum of explosive gas will get lower and lower, until by some accidental cause it becomes ignited. These spaces are sometimes ventilated temporarily by means of hangings of brattice cloth.

3. At one part of the mine a sudden irruption of gas may take place, which may vitiate the air current to an explosive extent, and may even in some cases overpower it altogether; if, however, safety lamps are used with caution, which are extinguished in presence of an excess of fire-damp, and the men are never permitted to work in dangerous atmospheres, such a result need not be the cause of an explosion. It may be said here that, however foul a mine may be, an explosion does not in any way necessarily follow.

4. Gas may not only be given off at the face of the coal, but in other parts of the workings through which the air travels on its way to the face, or possibly an over large extent of coal is traversed by the same air current, or the gas from the explosive stratum (mentioned in 3) descends and mixes with the air current, in which case, as the air proceeds, it becomes charged to a larger and larger extent with fire-damp, until, before it reaches the upcast shaft, it may have reached its explosive point.

From these considerations it will be seen that the maintenance of the ventilation in a through state of efficiency, a result which can only be obtained by the

most careful and constant supervision, is in reality the greatest safeguard from explosions. The safety lamp, of whatever form, should be regarded as a means of preventing accidents in unforeseen cases of emergency, and its use should never be allowed to render the attention to the ventilation of less importance.

In reference to the subject of ventilation, I would here call attention to an anemometer devised by Messrs. Arthur Le Neve Foster and H. Hall, in which the telephone has received one of its earliest applications. An anemometer of the ordinary kind used for determining the rate of the ventilating current is so arranged that, at every tenth revolution, a small pin on the axle strikes forcibly against a piece of steel watch-spring. This watch-spring is placed in front of an ordinary telephone, having the iron plate removed, the steel spring occupying in fact the place of the ordinary metallic plate. The telephone is connected by wires carried to any required distance with a second complete telephone, and on listening at this instrument every twang of the spring can be distinctly heard; by counting the number of these sounds in a given time, the number of revolutions of the anemometer, and consequently the rate of the air current, can be calculated. In this manner it is easy to ascertain at any point above ground the actual state of the ventilation. This ingenious form of instrument is quite successful in use, and is being employed already in some collieries, its extreme simplicity, coupled with the small amount of apparatus required, rendering it easy of application.

An explosion occurring in a coal mine, by the accidental firing of a mixture of fire-damp and air, will vary considerably in its effects, according to the different conditions under which the explosion takes place, thus the inflammable mixture may be of large or limited extent; it may be that the air and gas are mixed in their most explosive quantities, or be only just within the range of the explosive limits. Upon these points will depend the amount of local damage done by the accident, and the mechanical effects produced; in any case a mixture of this nature being ignited rapid inflammation of the whole takes place, a considerable amount of heat is developed, causing a corresponding expansion of the gaseous matter, and the mixture of fire-damp and air becomes resolved into new compounds. Starting with marsh gas and air, we have produced carbonic acid gas and steam mixed with the residual nitrogen contained in the original air, together with any excess of unfoul air or fire-damp which may have been present. The steam is almost immediately condensed to water, the other bodies remaining in the gaseous condition; those workmen exposed to the first shock of the explosion will suffer from the burning and scorching of the flame, and receive injury from the mechanical force of the combustion, which, it may be said, is sometimes, unfortunately, tremendous, hurling men, horses, timber, and stones to great distances from the first point of ignition; but the primary effects of an explosion are by no means the worst, life being dependent upon the proper supply of air; any interference with this supply will bring about most disastrous results, and a very common result of an explosion is seriously to effect the ventilation. Sometimes the ventilating apparatus is destroyed or seriously damaged, or by the blowing down of doors, brattices, and stoppings, the air current is diverted from its proper course, with the result of leaving portions, or it may be the whole mine, in a state of stagnation; drifts or galleries may be stopped up with heaped-up rubbish; a portion of the roof may fall, cutting off the necessary communication. These results would, under ordinary circumstances, lead speedily to the suffocation of all workmen existing under such conditions; but after an explosion, apart from the possible stoppage of the supply of air, this state of things follows with a much more rapid certainty, owing to the presence of the carbonic acid formed during the combustion. This carbonic acid is the much dreaded after or choke damp of the mine, and its victims are far more numerous than those from the other causes. One volume of marsh gas, on exploding, forms an equal volume of carbonic acid, and this carbonic acid alone will fatally vitiate ten times its own volume of good air.

The cause of the much greater fatality of carbonic acid in accidents will be seen from the following considerations. It has previously been stated that air containing 30 per cent. of marsh gas may be breathed for some time without injurious effects. On the other hand, air containing 3 per cent. of carbonic acid would speedily extinguish life. Now, suppose 1,000 cubic feet of an explosive mixture of marsh gas and air to be ignited, this mixture would contain about 10 per cent. (or 100 cubic feet) of marsh gas, which would form, when burnt, the same volume of carbonic acid, if measured at the same temperature; the volume of the aqueous vapour formed may be left out of consideration, as after the first expansion it immediately condenses to liquid water; but the whole of the oxygen contained in the original 1,000 cubic feet will have passed into combination as carbonic acid and water. Consequently, we have, in addition to the 100 cubic feet of carbonic acid, about 700 cubic feet of nitrogen, which formed a part of the original air; this nitrogen would be as unbreathable as the carbonic acid, and would produce immediate suffocation; that is to say, starting before explosion, with 900 cubic feet of air and 100 cubic feet of marsh gas, a mixture which is perfectly respirable, after explosion, we have 100 cubic feet of carbonic acid and about 700 cubic feet of nitrogen, a mixture absolutely fatal to life, and not only so, but a mixture which would require to be diluted with about 8 to 10 times its volume of fresh air to render it capable of supporting life at all. In this way the after-effects of an explosion may be most disastrous at places far removed from the locality in which the first ignition take place, seeing that the products of the combustion will pass onwards with the ventilating current vitiating it to the extent mentioned. Probably many lives might be saved in some accidents by a complete stoppage of the ventilation for a short period, as the air existing in places which have not suffered from the immediate explosion would be sufficient to allow the men time to reach the bottom of the shaft, or other place of safety. It is frequently recorded that, in this very endeavour, the workmen are overtaken by the current of fatally charged air and become victims to its effects.

The history of explosions in coal mines forms one of the most lamentable chapters in the account

of our industrial progress. From the very commencement of the working of coal mines, the risk and danger arising from this cause have had to be faced, and as the development of the trade has taken place, the proportionate increase of disasters has been but too surely recognised. Accidents in mines from other causes, most serious as they sometimes are, are, by care and foresight, far more readily under control. It is probable that accidents from fire-damp were proportionately as numerous and disastrous in early times as in more recent ones, but few records have been preserved. The great depth of the pits at the present time must also be regarded as tending to cause more explosions. A few of the most fatal explosions in modern times may be mentioned:—

In 1710, at Benshaven (Wallsend), a fatal explosion took place, with the loss of from 70 to 80 lives; this was in connection with the first attempt to work the low main seam in the neighbourhood of Newcastle. In 1812, at Felling, near the same place, an accident took place, causing the death of 92 men and boys. In 1821, a second explosion occurred at Benshaven, in which 52 lives were lost. In 1857, at the Lundhill Colliery, near Barnsley, 180 men and boys were killed. In 1862, at Risca, 142 were killed. In 1866, the terrible disaster happened at the Oaks Colliery, in which 334 lives were lost; also at Ferndale, in 1867, where 178 were killed; and the last great accident at Blantyre, in October last year, when from 200 to 300 lives were lost.

In underground mining, next to the proper supply of air, artificial light is necessary for the prosecution of the work. It would appear that lamps and candles were in use for this purpose in the very earliest mines, as in some of the old disused workings of such mines which have been discovered, ancient forms of lamps have been found, many of them being of earthenware. In England, candles have been more generally adopted; and where naked lights are used, candles form at the present time the great source of light to the miner. The absolute amount of light required in a coal mine is not great. In the absolute darkness of a pit the eyes are more sensitive to a small amount of light, and it is remarkable how much may be done with an exceedingly faint glimmer of illumination. The frequent explosions from the use of naked lights in early times, before any other form of illumination was introduced, led to the abandonment of dangerous workings, the coal being only obtained from those portions of the pit where tolerable immunity from danger existed. In cases where it was necessary to work in such places, various expedients were adopted. At one time higher wages were paid to those men who could work most successfully in total darkness, and it is stated that in some mines the phosphorescent light emitted by decomposing fish was utilised for the purposes of illumination, and in others smouldering tinder or amadou (a dried vegetable fungus) was employed, but in the bulk of the English coal pits candles were invariably used, the candles being supplied by the miners themselves. By their constant use, a considerable amount of expertness was arrived at by the workmen in recognising the presence of fire-damp. A candle flame in an explosive atmosphere, or in an atmosphere becoming explosive, is exceedingly sensitive in its appearance, and under ordinary circumstances will indicate the presence of fire-damp long before its amount becomes dangerous. In intelligent hands, a candle flame will recognise the presence of about 3 per cent. of fire-damp, a quantity far below a dangerous amount; the effect is seen by the formation of a bluish halo round the top of the flame. At the time when no other light was used but naked candles, even in the worst mines, it was usual for a workman to do, with much more risk, very much like what is done now by a fireman with his "Davy," namely, to go round the workings before the men entered them, and ascertain by an observation of his candle flame the safety or otherwise of the various places. The dangerous limit of an explosive atmosphere is ever shifting its position, and extreme caution is necessary when carrying a naked light.

In the early part of the 18th century Sir James Lowther made the observation that fire-damp was not ignited by the sparks from a flint and steel, and a Mr. Spedding, of Whitehaven, shortly afterwards sought to apply this fact practically, by an invention called the steel mill, in which a piece of flint was pressed against a rapidly revolving steel disc, thereby producing a stream of sparks; these sparks gave out a certain amount of light, never very great, equal to about one-half the light given by one miner's candle. The steel mill requires a man, or boy, to work it, and the expense of keeping so many of them going was great; it is stated that in one colliery near Newcastle, during the time the steel mills were being used, the expense incurred for maintaining them was £30 per fortnight. This expense and the feeble light might have been put up with, had the apparatus been safe; but, not long after its introduction, it was proved that, under certain circumstances, the sparks from the mill would inflame the fire-damp. This is quite natural. The explosive mixture is not inflamed by red-hot iron, but it is by iron at a white heat; the sparks struck off the steel by the flint vary largely in temperature, and may easily be raised to the temperature of ignition of marsh gas and air. Also it is probable that when a mixture of marsh gas and air is in just the proper proportions for complete combination, it is more sensitive to inflammation than at any other time. The first explosion with the steel mill, which was absolutely proved to have been caused by it, was at Wallsend in 1785, when the man who was working the mill survived, and could give an account of the origin of the accident.

In the early part of the present century, fire-damp explosions succeeded each other with such frequency that very serious attention was given to the subject, in order to obtain some form of light which could be used in a dangerous pit with some approximation to safety. A committee was formed in the northern districts with this view, and the subject was brought before various scientific men. In 1813, Dr. Clanny introduced a lamp in which a flame was kept burning entirely out of free contact with atmospheric air, the air being supplied to the lamp through a layer of water by means of a pair of bellows; this apparatus was exceedingly cumbersome and hence impracticable. The matter was brought before Sir H. Davy, at the Royal Institution, in 1815, who at once undertook to investigate the subject. He started with the ex-

amination of the properties of fire-damp and the conditions of its explosion (some of these properties have been already stated); the limits of the explosive mixture were also carefully determined.

In these experiments, when fire-damp was mixed with from five to six times its volume of air it exploded feebly, rising to a maximum of explosive power when the air was in the proportion of from seven to eight, and continuing to explode until the fire-damp was diluted with more then 14 volumes of air, beyond which point no explosion took place.

Davy also found that the temperature necessary for explosion was high, not being brought about by red-hot charcoal or red-hot iron. If carbonic acid or nitrogen was mixed with the explosive mixture, in the proportion of about 14 per cent., the power of exploding was lost. Further, if the mixture of fire-damp and air was ignited in a glass tube a quarter of an inch in diameter and 12 inches long, more than one second of time elapsed before the explosion passed to the end of the tube; through tubes one-seventh of an inch in diameter, the mixture could not be exploded when in the open air; metallic tubes were still more successful. Davy considered these effects to point to the conclusion that the effect of the mixture of carbonic acid or nitrogen, or of the tubes was due to the cooling influence which they exerted, and which lowered the temperature below the point at which inflammation could be maintained. This conclusion by a number of further careful experiments was confirmed, and it only remained in some form to apply these facts in the construction of a lamp. The flame of a common oil lamp was surrounded by a system of tubes of a less diameter than that through which the explosion passed. A lamp of this construction was faulty, inasmuch as the light was practically *nil*, and the tubes failed to supply the flame with the necessary amount of air. By reducing the length of the tubes and decreasing their diameters, Davy says, "I arrived at the conclusion that a metallic tissue, however thin and fine, of which the apertures filled more space than the cooling surface, so as to be permeable to air and light, offered a perfect barrier to explosion from the force being directed between, and the heat communicated to an immense number of surfaces." In this fashion, a flame surrounded with a cylinder of wire gauze, became what has since been called a "safety lamp." The further development of this lamp in the hands of Davy consisted in the determination of the requisite fineness of the gauze, which was found to be such as contained 28 wires, or 784 apertures (the number has since been increased) to the square inch; the cylinder of wire gauze was fitted above and around an ordinary oil lamp with a wick, the upper part of the gauze being made double. On plunging such a lamp into an explosive atmosphere, the inflammable mixture enters the lamp, is ignited, and fills the lamp with a blue flame, which, however, is not communicated to the external explosive atmosphere, as the flame cannot penetrate the gauze owing to the rapid conduction of the heat, the hot gases which do get through being at a temperature far too low for the ignition of the external mixture. If the lamp be kept continuously in such a mixture, the gauze will get red-hot, but Davy considered that, even in this state, it was incapable of causing an explosion. This, however, under certain circumstances, has since been proved not to be the case, and safety lamps should never be exposed for any lengthened period to an explosive atmosphere.

These lamps were rapidly introduced, although having to contend with some prejudice, and for a time unbounded faith was placed in them, which was shared fully by the distinguished discoverer; however, the title "safety lamp," as will be afterwards pointed out, is misleading. It has often been recorded, in reference to many discoveries, that two observers have arrived at the same result while pursuing distinct paths; this appears to have been the case with Davy and George Stephenson. There is no doubt that previously to 1815, Stephenson had tried experiments in one of the northern collieries with a lamp which in reality depends upon the same principle as the "Davy," but which Stephenson considered to be due to another, *i.e.*, that if a current of an explosive mixture travels upwards past a flame at a greater rate than its explosion would proceed downwards, no communication of ignition would ensue, which is perfectly true, and may be experimentally illustrated; but this rapidity of draught is not obtained with a flame burning under ordinary circumstances. In the Stephenson lamp, the air was admitted by a number of small tubes situated below the flame; afterwards these tubes were reduced to small holes in brass plates, a similar set of holes being placed at the top of the lamp, the body of which was made of glass. Stephenson says:—"My first lamp had a chimney at the top of the lamp, and a tube at the bottom to admit the atmospheric air or fire-damp and air, to feed the burner or combustion of the lamp. I was not aware of the precise quantity required to feed the combustion, but, to know what quantity was necessary, I had a slide at the bottom of the first tube in my lamp to admit such a quantity of air as might eventually be found necessary to keep up the combustion."

"The lamp not burning well, it struck me that if I put more tubes in, I should discharge the poisonous matter which hung round the flame by admitting the air to its external part. . . . . Afterwards, I altered the lamp so that air was admitted by three small tubes inserted at the bottom of the lamp, the openings of which were placed on the outside of the burners, instead of having one tube opening directly under the flame. I thought that the air would have easier access, and the effect might be the same if I cut away the middle of the tubes; and that the flame, if it passed the apertures at the top, would not communicate the explosion to the gas beyond the plate below. I constructed a lamp upon this principle, and found that the holes having been punched very small, the flame never passed even through the first plate." This non-passage of the flame through the plates is undoubtedly due to the same cooling effect explained by Davy; and the two lamps have the same fact as their fundamental principle. In the later forms of the Stephenson lamp the glass is surrounded by a wire-gauze cylinder.

Both the Davy and Stephenson lamps give but small amounts of light. The amounts are—Davy, about ·2 of a sperm candle, burning 120 grains per hour; Stephenson, about ·15 of a sperm candle, burning at the same rate.

Since the introduction of the safety lamp, no fundamental change has been effected in it. Various lamps have, from time to time, been introduced, most of which have been tried and found wanting; the best forms only have survived, and these are represented at the present time by four patterns, which are in general use, according to the district. The first is the ordinary Davy, consisting of an oil lamp surrounded with a cylinder of wire gauze, which is of double thickness at the upper part; the fresh air enters, and the products of combustion escape directly through the meshes of the gauze. In the early lamps the oil vessel of the lamp had a tube opening into the air, which was closed by a screw plug, for the purpose of the fresh supply of oil, it was found to be a source of danger, and has been, in all later lamps, abolished, the lamp now having to be taken apart in order to be refilled. A small wire, working tightly through a tube, and passing through the bottom of the lamp, serves, roughly, to trim the wick. The Davy lamp of this pattern is exceedingly sensitive to the presence of fire-damp, the indications of the flame being very prompt and delicate; and, probably, for the purpose of testing the state of the air, it is the best lamp. Of this, however, more hereafter.

The second form of lamp is the so-called Stephenson lamp, in which the flame is surrounded by a glass chimney within the gauze. The supply of air is obtained through a number of minute apertures in a circular brass plate at the base of the chimney, and the products of combustion issue through somewhat similar perforations at the top. The Stephenson lamp, in explosive atmospheres, is extinguished. In both these lamps the light emitted is very feeble.

The third form is the so-called "Clanny" lamp, a modification on the Davy principle of some points of the original lamp of Dr. Clanny. The wire gauze cylinder is confined to the upper part of the lamp, that part surrounding the flame being of uncovered glass. The ventilation of this lamp forms a beautiful illustration of the action of convection currents. The air has to enter at the top, and descend to the flame, and the products of combustion have to pass up, and escape through the same gauze. If a little smoke be blown into such a lamp while burning, it will be seen that the pure cold air descends at the side of the lamp, turns round at the bottom, and passes to the flame, the hot gases formed pass up in a central column, and escape at the top of the lamp. This lamp necessarily gives more light than either of the former; there is, however, the danger of breakage of the glass. This danger is not by any means so serious as it might at first sight appear, if the glass has been carefully annealed, for, should a crack occur, the opening so produced is usually far less in area than one of the apertures in the wire gauze.

These three lamps are largely used in England; the Stephenson, however, is not found generally out of the northern districts.

The fourth lamp is the Mueseler, a Belgian lamp, the use of which is compulsory in the Belgian pits, in which safety lamps have to be employed. In the above-mentioned Clanny lamp the combustion is not quite perfect, as the supply of air to the flame is apt to be interfered with by the passage through the gauze of currents of air; this is overcome in the Mueseler lamp—which essentially is very much the same as a "Clanny"—by the introduction of a metal chimney above the flame, and enclosed within the wire gauze. The top of the lamp is also separated from the bottom by a horizontal piece of wire gauze placed at the base of the chimney; this causes a more perfect division of the descending and ascending columns of air, and at all times brings the pure air directly to the flame; in this way a steadier and better light is obtained. In the case of any safety lamp care and caution must be exercised in its use, otherwise it will be a mere trap giving a false notion of security. A miner in whose hands a safety lamp is placed should be in possession of a certain amount of knowledge of the principles upon which these lamps depend for their action, and the circumstances under which they cease to be safe. That such knowledge is very seldom so possessed is to be greatly regretted, and it is to be hoped that when a scheme of technical education is developed, such knowledge will be imparted at least to those who hold positions a little superior to that of the ordinary workmen.

PRACTICAL EXAMINATION IN MUSIC.

The following correspondence has passed on this subject. The letter from Mr. Colin Brown was in response to the notice on the subject issued to Institutions in Union with the Society. This was submitted by the Secretary to Mr. Hullah, the Society's Examiner in Music, whose comment follows Mr. Brown's communication:—

192, Hope-street, 27th March, 1878.

Dear Sir,—I have consulted my students regarding the proposed examination. They have been very much disappointed by it, as fifty or more would willingly go in for such an examination as I had to some extent prepared them for. They hoped for some such examination as Professor Macfarren at one time conducted in harmony and musical composition, with the addition of singing, playing, and analysing music of various kinds.

The 1st and 3rd of the tests you send are fully covered in the ordinary Sol-fa certificates, and the 2nd is strongly objected to as a mere test of sounds in fixed pitch, without any real musical value. Instead of a series of arbitrary sounds, why should not a piece of music—such for instance as a double chant, be sung or played in four parts—and get the students to write down one, two, or more of these as they hear the piece played over. This would be a simple and perfectly satisfactory test of the student's ear and knowledge of sounds, just as writing down from dictation a piece of good composition would be of his knowledge of language, while, if I understand your syllabus a-right, your proposed ear test means nothing more musically than writing down a few words dictated at random from a dictionary, and containing no meaning or idea, would be of a student's literary attainments.

I am very sorry not to be able to return you a more favourable reply. I am satisfied that a thorough practical examination emanating from your Society, open to all comers, in any notation, and equal at least to those of other bodies, would be one of the most useful and generally popular in the kingdom.

I hope that before next session such an examination may be fully matured. It is now quite too late to do anything in Scotland this year.

Colin Brown,
Evening Lecturer on Music, Anderson's College.

P. Le Neve Foster, Esq.

Grosvenor-mansions, Victoria-street,
April 13th, 1878.

Dear Mr. Foster,—That Mr. Colin Brown should object to the scheme of Practical Examinations in Music, published in the *Journal* of the Society of Arts for March 22, is not astonishing. I owe it to you and the Society, with whose confidence I have been honoured for so many years, to try and show that his objections are frivolous and vexatious.

To the first and third of the tests to which we propose to subject candidates be objects, because they "are fully covered in the ordinary sol-fa certificates;" *i.e.*, he objects to his students going in for an examination wherein they would, one and all, inevitably gain two-fifths of the whole number of marks attainable in it. Voice and ear, however, it would seem, are no parts of "such an examination" as Mr. Colin Brown had, "to some extent, prepared his pupils for;" though what preparation could possibly be needed for students whose competence was fully guaranteed by another certificate, in which he of course had implicit confidence, it is hard to understand.

To the second test he objects, as "a mere test of sounds in fixed pitch, without any real musical value." I had hoped that I had seen the last of this baseless fiction of fixed or absolute pitch, in a paper of Mr. Colin Brown's of the year 1874. It is needless now to do more than repeat that I have never taught or examined on any principle or method of fixed or absolute pitch; and moreover that I have never heard of anybody who had done—or, more properly, tried to do—so.

The easiest, and therefore the first test of a student's consciousness of the musical value of what he hears should surely be applied through melody; the more difficult, and therefore the second test, through harmony. Were one of Mr. Brown's students under examination to name to me correctly and readily the sounds composing two or three passages of melody, I should assuredly ask him to do the same in respect to two or three single combinations, and then to as many successive combinations, in harmony. Does the Evening Lecturer on Music in Anderson's College, Glasgow, mean to assert that a passage of anything worthy of the name of melody, every note of which would inevitably have relation to the one which preceded and followed it, and to a tonic with which the student called upon to recite it would be thoroughly impressed, is analogous to, has any sort of resemblance to "a few words dictated at random from a dictionary, and containing no meaning or idea?" Or does he mean that your examiner is capable of placing sonnds in such absurd order or combination as to prevent their having any musical relation to each other? The greater includes the less. If Mr. Colin Brown's students can write down, with even approximate correctness, one or two double chants that they have never heard before, when played or sung to them, they will write down, or name, with ease, and with perfect correctness, any reasonably constructed passage of melody, or any simple combinations or successions of combinations in harmony.

Mr. Colin Brown, I rejoice to find, makes no objection to our fourth test; his objections are limited in their application to only three out of our four. Nor does he make any reference to the tests in instrumental music.

I fear there is no likelihood of such an examination as Mr. Colin Brown may "to some extent prepare his pupils for," being "fully matured"—for his and their exclusive convenience. The Society of Arts has to deal, not with this or that institution, or method, but with all institutions wherein, and all methods through which, honest work is done or even attempted. For myself, if I examine his or anybody else's pupils, I must have the fullest liberty, as I have had in every other examination I have ever undertaken, to do so in my own way.—I have the honour to remain, dear Mr. Foster, very faithfully yours,

John Hullah.

P. Le Neve Foster, Esq.,
Society of Arts.

MISCELLANEOUS.

PARIS EXHIBITION.

[from a correspondent.]

The inauguration of the Exhibition is announced for the 1st of May by the President of the French Republic and six princes of reigning families; England to be represented by H.R.H. the Prince of Wales; Spain, by his Majesty Don François d'Assise; Italy, by the Duke d'Aoste; Holland, by Prince Henri des Pays Bas; Denmark, by the Prince Royal of that country; and Russia by the Prince of Leuchtenberg.

The *cortège* is to be formed in the following order:—The Prefect of the Seine and the Prefect of Police; the Minister of Agriculture and Commerce and the Commissaire-General of the Exhibition, M. Krantz; the Princes; the President of the Republic and the Presidents of the Senate and Chamber of Deputies; members of the Diplomatic Corps; Ministers and Under Secretaries of State; delegates from various Commissions; members of the superior Commission of International Exhibitions; foreign Commissions; the principal officials of the Exhibition.

The opening of the Exhibition will be announced by salutes of 101 guns from the Isle de Cygnes, near the Champ de Mars, from the Invalides, and from the great fort of Mont Valérian.

No persons but the bearers of season tickets, including of course those of jurors, officials, exhibitors, and others, will be admitted on the opening; on the second day ordinary tickets, at one franc, will be admitted; these latter are now on sale at all post and telegraph offices, and tobacconists, and at kiosques specially devoted to the purpose in the neighbourhood of all the entrances to the Exhibition on each side of the Seine. The total number of entrance gates is no less then fifty-eight.

The greatest activity reigns, of course, now the first of May is so near, but what is still better is the fact that the work has made great progress, and the change that has been effected in the condition of the ground is truly marvellous, for the weather has not been favourable; mud and rubbish are fast disappearing, and flower-beds and gravel-walks begin to assume proper form and consistency. The grand avenues which lead from the bridge of Jena to the Champ de Mars building are now accessible, and are being decorated with statues; in a day or two the platform of the bridge of Jena will be finished, when the connection of the two sections of the Exhibition will be complete.

A feature of the Exhibition which promises to be amongst the most attractive, that of the process court, which occupies the vestibule in the rear of the building, is developing rapidly; counters, stalls, small workshops, looms, including a fine ribbon loom from Saint Etienne, spring up in an hour or two. The exaggerated stories about the backwardness of French exhibitors have evidently stimulated them, but they cannot bear that their beautiful goods should lose the last of their freshness, but nearly all the cases are ready, and in some few of them notices are exhibited to the effect that "M. ——'s exhibits will be all ready on the opening day, even should the case be empty on the night before."

Extraordinary objects meet the eye in every direction: a terrestrial globe in copper, about 12 ft. in diameter, to be mounted on a high column; the tail of Charlemagne's horse, weigbing about a thousand pounds (the group to which it belongs weighs sixteen tons). Canada has uncovered a fine specimen of its mineral treasures, a pyramid in one piece of red marble ten feet high, and a bold plinth of the same material.

In the French fine-art galleries are more than fifteen hundred pictures and pieces of sculpture, four hundred of the latter being from museums and galleries in Paris,

Versailles, and Saint Germains, and the German and other salons are filling.

In short, all the Commissions are doing their utmost, and the result cannot fail to be eminently satisfactory. In some parts of the building, as for instance, around the Chinese and Japanese courts, notices have been affixed, prohibiting persons from collecting and thus disturbing the workmen and decorators.

The grand pavilion of the City of Paris in the central garden is nearly finished; it covers a space of three thousand metres, and presents many remarkable features which will command attention. This pavilion is to be a permanent ornament of the city, but not in its present position; it is to form a national gymnasium.

The collective workmen's exhibition, which was only set on foot last month, is announced to be opened on the 1st of June. It will be remembered, perhaps, that the municipal authorities of Paris voted 50,000 fr. in aid of this undertaking. A building of rough, unhewn stone has been erected by the syndical chambers of masons and carpenters; it is about 750 ft. long, and 16 ft. or 17 ft. high, the area being nearly 22,000 square feet, of which half will be available for exhibits. in addition to wall space. The number of exhibitors is reported to exceed 600. The design of the building is elegant, and it will be further embellished with a garden, which the authorities have undertaken to supply at the cost of the city. The building is said to have cost 43,000 fr., and 27,000 fr. remain in hand for the completion of the arrangements, 20,000 fr. having been subscribed by the syndical chambers which have undertaken the organisation of this exhibition. The building was visited the other day by M. Krantz, the director of the Exhibition of which it forms a part, the President of the Municipal Council, and other officials.

A curious exhibit is to be made by Dr. Oré, namely, human and animal brains, covered with silver or other metal by electro-deposition, and, consequently, giving them solidity while preserving every contour without appreciable alteration; a number of specimens were exhibited at the School of Medicine the other day, in the presence of a large attendance of the faculty. It is not stated how the surface is prepared to receive the deposited metal; presumably, some one of the ordinary processes for obtaining a conducting surface is employed.

THE CULTURE OF CINCHONAS IN JAVA.

The *Pharmaceutical Journal* gives the following abstract from the report on the Dutch Government plantations for 1877:—

First Quarter.—The month of January was very stormy, with relatively a small quantity of rain. At Ragrak the plants suffered very much, about one thousand trees being uprooted. In February and March there were continuous rains. 21,128 Ledgeriana, 1,290 succirubra, and 6,092 officinalis plants were planted. The incessant rains prevented the commencement of the collection. The Ledgeriana plants flowered freely, and application for seeds of this kind have been made from all sides. At the end of March the number of plants was:—

	In the nurseries.		In the open air.
Calisaya Ledgeriana	214,489	..	1,163,405
Succirubra and Caloptera	12,945	..	163,663
Officinalis..............	81,607	..	509,906
Lancifolia..............	500	..	36,054
Micrantha	—	..	512
	309,541		1,873,540

Second Quarter.—Rain fell during April, but the months of May and June were dry. This early dry weather was very favourable for the harvest, which was commenced in the middle of May.

A royal decree of the 28th of May authorised the Director to increase the number of cinchona plants in the plantations by one million.

The collected barks, examined by Oudemans and Stellingwerff, were found to be all that could be desired. The waste from the barks, which was formerly exported after previous pulverisation, is now sent away just as it is, with the result that it is more sought for.

In consequence of the favourable season it was possible by the end of June to send to Yicao 25,568 pounds of cinchona bark, whilst a nearly equal quantity was quite ready for a fresh consignment. It is estimated that the general harvest amounted to upwards of 100,000 pounds (Dutch).

Lately the cinchonas have suffered from the ravages of a hemipterous insect, the *Heliopeltis theiovora*, which also attacks the tea plant. These insects, when winged or in the young unwinged state, feed upon the juices contained in the younger portions of the bark. The parts invaded by the insects cease to grow, the leaves as well as the young branches droop, shrivel, and become black, and when all the young branches are attacked, which is generally the case, the plant ceases to grow until the new buds form. For some time past precautions have been taken against the multiplication of this pest, and the destruction of birds in the neighbourhood of the cinchona plantations has been forbidden. It has also been recommended to cut off and burn the young branches that have turned brown, and contain the eggs of the insects. One point worthy of notice is that the low lying plantations suffer most from the attacks of this insect; in those above 3,000 feet attacks are rare; whilst above 6,000 feet the insect does no harm.

Third Quarter.—These three months were characterised by remarkably dry weather. Rain was rare, and in some stations only one or two rainy days were reckoned. During the whole of this period the temperature frequently descended to 6·6, and twice there was a slight frost during the night. This extraordinary dryness did not injure the larger plants, but many of the smaller plants succumbed. The frosts were very injurious at some of the plantations. The great drought also gave rise to several fires, which in some places spread to the plants. Towards the end of August, when the insects had become rare, the branches that had suffered from them were cut off and burnt.

The harvest now terminated. During the three months there were sent to Yicao, for shipment to Holland, 63,220 pounds of bark, and 3,130 pounds for the medical service in Java. About 7,000 pounds more were ready for consignment. In September an enormous quantity of seeds was sent out. At this time the numbers of the plants in the plantations were as follows:—

	In the nurseries.		In the open air.
Calisaya Ledgeriana and Hasskarliana	201,969	..	1,118,717
Succirubra and Caloptera	32,437	..	153,785
Officinalis..............	83,207	..	503,268
Lancifolia..............	500	..	36,017
Micrantha	—	..	512
	318,113		1,812,299

The Electro-metallurgical Company of Brussels has lately completed a colossal statue of Jan van Eyck, in bronze, by the system of electric deposition. The galvanic process occupied several months, although a thickness of but six to eight millimetres was attained. It is believed to be the largest article which has been produced by this method, being over 12 ft. in height, and is regarded as a much more perfect imitation of the model than could be obtained by casting.

The fruit of the wild orange tree, which flourishes widely in Florida, has at last been turned to account in the manufacture of marmalade, syrups, &c. Formerly thousands of bushels of this fruit were allowed to rot neglected on the ground.

TEA-PRODUCING DISTRICTS OF CHINA.

The report upon trade at the treaty ports in China contains a notice of the markets from which the various teas are purchased, which has been introduced by the Inspector-General of Customs for the use of non-residents who are interested in this particular subject.

The producing districts of black-leaf Congou lay some years since exclusively in the Hupeh and Hunan provinces; and this description was hence divided into Oopacks, those coming from the former, and Oonams, those coming from the latter province. But of late years the choicest Congous have been produced in the Kiangsi province. These are known to commerce as Ningchows, from the fact that they are prepared in the Ining-chow district. This leaf used to be converted into green tea; and its superiority is due mainly to the additional care which, in consequence of the relatively high price paid for green tea, was expended upon the culture of the plant and picking of the leaf. Among the Oopacks, the chief descriptions are Tsung-yangs (so named because grown in the *hien*, or district, of Tsung-yang, in the prefecture of Wuchang) and Yanglow-tungs, which derive their title from a place of the same name situated in the Puk'i district, also in Wuchang prefecture. Amongst Oopacks are also included Changso-Kais; but these teas should properly be classed amongst the Oonams, as they are grown in the neighbourhood of, and take their name from, the town of Changshow-Kieh, in the Pingkiang district, Yoochow prefecture, in the province of Hunan. Of Oonams, the chief descriptions are Oanfas, from the Anhwa district; Lilings, from the district of the same name; and Shantams, as is pronounced by Cantonese the name of the district whence they come, Siangtan. This latter district, as well as the two preceding, is situated in the Changsha prefecture. During the early part of the season these teas find a market at Hankow, but subsequently the bulk are forwarded on by the Chinese owners to the more important port of Shanghai. The Ninchows are disposed of to a small extent at Kiukiang, but the bulk are forwarded from that port during the early part of the season to Hankow for sale, chiefly for the Russian market, and subsequently to Shanghai, to which place also are shipped the Hohows, another Kiangsi tea, named from Hokow, a town in the Yuenshan district, Kwangsin prefecture. Oonam and Ningchow teas constitute what are known upon the London market as Monings.

Of the Furkien or red-leaf Congous, the principal varieties are the Pakling, Panyong, Chingwo, Suey-Kut, Kienyong, Young-how, Sayune, and Kaisow, these names being, as in the case of the northern teas, the pronunciation of the Chinese characters as given by the Cantonese comparadores, Romanised. The Paklings and Panyongs are both grown in the Foochow prefecture, the former deriving its title from the Pei-ling, or northern mountain range, about 15 miles north of Foochow, which gives its name to the district; the latter from Tanyang, a small town about 35 miles north-east of Foochow. The Chingwos, Suey-Kuts, and Kienyangs come from the Kienning prefecture, the first and third deriving their names from the *hien* in which grown, respectively Chengho and Kienyang; the second from Shuiki, a small town in the Kienyang district. The Sayune and Young-how varieties are produced in the Yenping prefecture, the former word being intended to reproduce the name of the district from which they grow—Sha-hien, Cantonese Sa-yun; the latter variety derives its name from a small town in the neighbourhood of which it is grown, Yang-Kow, in the Shunchang district; Kaisow takes its name from Kiehshow, an important mart in the Shaowu district, in the prefecture of the same name. The market for these teas is Foochow. Another description of black tea, exported from Foochow, Amoy, and Tamsui, north Formosa, is Oolong. The name means "Black Dragon," and is said to have been given to this class of tea because a grower in the Kienning prefecture, struck with the superior quality and fragrance of the leaves of one bush, found, on examination, a black serpent coiled round its stem. The bush hence came to be known as the "Black Dragon," and was much sought after for grafting purposes. The tea exported from Canton is all grown within the Kwangtung province, the different kinds taking their names from the districts in which they are produced, as known in the Canton dialect. Among Congous, the best-known kinds are Tayshan, Sichu, Tsing-Yune, Kon-Kok, and Han Yune, which come respectively from the Tashan locality in the Hoshan district, the Sichu locality in Nanhai district, Tsingyuen district, the Kiangku locality in Kwangning district, and Ho district. Of scented Capers, the chief kinds are Kowleen, Kon-Koke, Loting, and Han Yune. Kowleen takes its name from a small locality in the Hoping district, and Loting from the district of that name. The chief grades of scented orange Pekoes are Tayshan, Kon-Koke, Shu Hing, Tan Choke, Loting, and Pak Suey, the two latter being principally short leaf. Shu Hing comes from Shaoking prefecture (locally pronounced Shu Hing), Tan Choke from the Tochu locality in Kweihi district, and Pak Suey from the Pehshui locality in Hoshan district. The other localities have been already given.

The green tea districts are situated in the Anhwei and Chehkiang provinces, but chiefly in the former. A mountain range divides from north to south the tea-growing districts of the former province. The tea which is produced to the west of this range finds its way through the Poyang lake to Kiukiang, whence it is shipped by steamer to Shanghai, where the whole business in green tea is concentrated. That which is grown to the east of this range, together with the production of the Chehkiang province, is carried in boats *viâ* Yikiao to Ningpo, and thence by steamer to Shanghai. The principal classes are Pingsuey, Moyune, Tienkai, and Fychow. The Moyune and Tienkai are both grown in the Anhwei province, in the Hweichow prefecture, and are transported to Kiukiang. The former derives its name from the *hien* in which it is grown—Wuyuen; the latter from a locality of the name in the Kimen district.

The Fychow is also of Anhwei production, its designation being a generic name for all the Hweichow (Fychow) teas grown to the east of the range above mentioned. Pingsuey is of Chehkiang growth, and derives its name from a small town, Pingshui, in the neighbourhood of the town of Shaohing-fu. Both these latter descriptions are taken to Ningpo. Green teas are also exported from Canton. These come principally from Kowlien in the Hoping district, from the Loting district, and from Kiang-Ku (pronounced locally Kon-Koke) in Kwangning district, all of which are within the Kwangtung province.

INVENTION OF THE REAPING MACHINE.*

In continuation of the previous notes on this subject, Mr. G. H. Thompson forwards the following extracts from two letters to Mr. John Common relating to his reaping machine:—

From Mr. Robert Nicholson, South Charlton.

Dear Sir,—I was present in Alnwick at the July Fair-day when you met Mr. John Nichol (the late Mr. Thos. Brown's son-in-law), who said he had been anxious to see you, being wishful to inform you of your patterns which Brown (when living in Alnwick) had got from you to make castings for your reaping machine: had been given by him (Mr. Brown) to Mr. McCormick, with which the reaper exhibited in London by the latter exactly agreed.

(Signed) Robt. Nicholson.

* See *Journals* for March 22nd and April 5th.

From Mr. Robert Greenwell, South Sunderland.

January 22nd, 1860.

Dear Sir,—I called and saw Mr. and Mrs. Robt. Nichol last night, and was informed by the latter that she went to America in 1848, and was told by her father that he had given your patterns to Mr. McCormick some time before.

(Signed) Robt. Greenwell.

AGRICULTURE AND INDUSTRIES OF CORFU.

In the Island of Corfu, agriculture as a science must be considered as still in its infancy. Consul Sir C. Sebright states that more than one attempt has been made to institute model farms, first by Sir Howard Douglas, and again by Lord Seaton. To those establishments training schools were attached, where instruction, free of expense, in the theory and practice of agriculture, was imparted to all who chose to avail themselves of the offered advantage. But the attendance of pupils was scanty from the outset, and speedily fell off to such an extent that the schools had to be closed and the enterprise abandoned. It may be said, in fact, that a taste for agricultural improvements, or for improvements of any sort involving a change in old-established routine, does not exist among any class of the population. The class of proprietors who ought to be the foremost to show a good example were content to depend for their subsistence on the often precarious produce of their vines and olives, eked out perchance by salaries derived from public employments, of which under the British protectorate they enjoyed an almost exclusive monopoly. The rural population, who, as a body more or less hold the lands of the large proprietors either in *colonia* or *emphyteusis*, are in a marked degree averse from labour, even more so perhaps than is common to the inhabitants of other olive and wine-producing countries.

As to the grain-producing capacities of the island, it may be admitted that there is no continuous extent of arable land under actual conditions sufficient to find employment for a strictly agricultural population. The broad valleys between the ranges of hills by which the island is intersected in all directions, are too marshy to admit of being cultivated to any extent; these marshy tracts have been for ages bygone fertile in malaria, the deadly effect of which in some sort justifies the indolent habits of the people. To this cause and to no other is it attributable that the population of the island, as to numbers, has for so many years remained stationary, nor will it be otherwise till its atmospheric conditions are ameliorated by the proper drainage of the marshes and low-lying lands throughout the whole extent.

The article soap appears destined to become one of the principal industrial products of the island. The chief obstacles in the way of increased production, namely, the scarcity or dearness of the two main substances which enter into its composition, are in a fair way of being removed. The first and most costly of these ingredients, olive oil, is being produced in increasing quantities. The method employed for crushing the olives preparatory to extracting the oil, is of the most primitive kind; a vertical stone cylinder of great volume and weight, attached to a shaft, is made to revolve by horse power in a slightly concave bed of the most solid construction. In this receptacle the freshly gathered olives are placed, and by the action of the revolving cylinder reduced to a pulp more or less comminuted according to the degrees of pressure. The pulp is then removed and inclosed in flat circular bags of about two feet in diameter, and then subjected to the action of a strong screw press, set in motion by a lever projecting horizontally, and worked by the united efforts of several men. When under this operation, which is most laborious, the oil ceases to flow; the now strongly impressed pulp is withdrawn, and collected in heaps out of doors, where it is left to dry or ferment according to the accidents of the weather. Till recent times this refuse was occasionally employed as a manure, and partly used by the bakers and for heating their ovens. For this latter purpose it was largely exported to Malta, where it fetched remunerative prices; and this traffic continued till it was put a stop to by the imposition of an export duty by the Hellenic Government, which absorbed the whole of the profits previously obtained.

The accumulation of this material in the islands, in all of which olive oil forms one of the chief products, had become enormous, in spite of the local consumption for the purposes above stated, when it occurred to some ingenious person to subject it to a chemical analysis, with the view of turning its properties to some useful account. The result was that it was found to contain from 2 to 4 per cent. of pure oil. This discovery once made, in 1869 a firm, composed of three enterprising capitalists, was established, and works on a large scale were constructed, with a view to extracting the oil. The process employed is both simple and ingenious, and has turned out a complete success. It consists in forcing, at a high temperature, bisulphide of carbon through a given quantity of the refuse, which, after being reduced to a fine powder by being passed between cast-iron rollers, is enclosed in an air-tight metal cylinder of great strength, communicating with another receptacle or reservoir, also air-tight, through which the bisulphide is forced from beneath, carrying along with it the oil disengaged by its action. After a sufficient time allowed for cooling, the reservoir is opened, when the oil, now of a greenish colour, but almost inodorous, is found floating on the surface of the bisulphide, whence it is baled out and preserved in casks. The bisulphide remains unchanged in its qualities, and but slightly diminished in quantity, ready, with slender additions, for operating afresh. This substances is now known in commerce under the designation of "pyreune oil," from the Greek word signifying core, or kernel.

The second ingredient is soda, which has to be wholly imported from abroad, at a proportionately high cost. An almost unlimited supply might be obtained were the manufacture of sea salt, from which it is extracted, carried on to an extent of which it is capable. It is satisfactory to observe that a concession of the extensive salines at the western extremity of the capacious bay, which extends beyond the town and port of Corfu, has been obtained from the Government, on advantageous terms, by a private company, with the view of employing the produce in the manufacture of soda, for which works are in the process of erection. The soap which is made by hand is, for the most part, exported to Continental Greece and Turkey; as, also, a portion of it, to Trieste and Venice. It is packed in deal boxes, containing 150 lbs. each. As the profits to be derived from introducing this article into the English market have not escaped the calculations of the manufacturers, it is but fair to state that the purer ingredients in its composition are occasionally adulterated by an admixture of fuller's earth, which, while it adds considerably to its weight, impairs its quality.

The aggregate force of the steam-engines existing in Prussia in 1861 was 167,193 horse power, in 1875, the corresponding aggregate force had grown to 685,559 horse power, showing an increase of 347 per cent. in the 14 years under review. Railway engines are excepted from the comparison in each year.

Samples of rice from Central Africa, grown about 100 miles south of the Zambesi River, and 200 miles from the coast, have been exhibited at the Chamber of Commerce, Port Elizabeth, packed in bags made from fibrous bark. The rice, it is stated, may be bought from the natives at about 4s. per 100 lbs.

CULTIVATION OF LIMES IN MONTSERRAT.

Under the auspices of the Montserrat Company, has recently been issued a descriptive account of the island of Montserrat in the West Indies, chiefly with regard to the cultivation of the lime for the production of lime-juice. Though this fruit (*Citrus limetta*) is cultivated to a small extent in Jamaica and other West Indian islands, it is in Montserrat that its growth is conducted in anything like a large scale, and this has only been within the last few years. This little island, which is only about eight miles long and five miles broad, is situated in 16·45 north latitude and 61° west longitude. It is described as being the most healthy of the Antilles, and certainly one of the most beautiful, the steep sides of the island, rising from the sea, being covered with virgin forest abounding in graceful cabbage, palms, tree ferns, and bananas, while the slopes of the hills on the coast are covered with emerald cane fields, or with the darker verdure of the lime orchards. The discovery of the island by Columbus in 1493, its colonisation by English settlers in 1632, the French possession of it in 1664, its restoration to England in 1668, the second French possession in 1782, and its final occupation by the English two years later, are facts well known and frequently brought to the mind of residents in the island by the mementos of these contests in the form of massive guns, which even to the present time it seems may be found on the tops of the steepest ranges, partially concealed in the thick tropical vegetation. Towards the close of the last century sugar was the staple article of culture in Montserrat, and continued to be so, though in a declining ratio, till about ten years ago, at which time Sturge's Montserrat Company was formed. The sugar-cane is still grown and sugar manufactured, but in much smaller quantities than heretofore. The principal product of the island is now the lime fruit; though lime orchards were first formed so far back as 1852, it was not till the Montserrat Company took up its cultivation that it became remunerative. The plantations at the present time are stated to cover more than 600 acres, and to contain 120,000 trees. They are generally planted 15 feet apart, and it is said that no more beautiful sight can be imagined than these orchards, when the trees are laden with their brightest fruits, which are gathered by native women, who carry them down from the plantations in baskets on their heads. The perfume imparted by the trees, either in flower or fruit, is very delicious. The leaves themselves are so fragrant that they are universally used in the West Indies to perfume water in finger glasses at dessert. "The lime harvest is heaviest from September to January, but the Montserrat plantations yield a considerable return all the year round. The trees require regular pruning, and to be freed from the mistletoe, clodder, and other mischievious parasites, so that their cultivation during the years that elapse before they come into bearing has involved a very considerable outlay. The fruit is carried down to two central manufactories, where it is sliced by water power, and afterwards squeezed until all the juice has been expressed. The juice from the choice fruit is promptly headed up in casks, so that it may not be exposed to the air; that of the inferior fruit is boiled down for the citric acid it makes."

After the casks of lime juice arrive in this country, and have found their way to their proper destination, the contents are allowed to settle, after which it is clarified and bottled, when it is ready for the market. It is said that the bulk of the lime juice that is offered in the English market is made from the fruit of the trees that now grow wild so abundantly in Jamaica, Tahiti, and elsewhere. In some parts of Jamaica the negroes go about the country collecting the fruits from under the scattered trees, and squeezing the juice into a pail with an ordinary kitchen lemon squeezer. The juice so procured is bought by the merchant at a few pence per gallon. "As lime juice decomposes very rapidly when exposed to the atmosphere in a tropical climate, and acquires a disagreeable taste in a few hours, unless the air is excluded from it, it may easily be imagined that the juice so obtained does not please the English consumer, even if it has not, as is sometimes the case, been adulterated with salt water by the negroes to increase its bulk. In fact, until the introduction of the Montserrat juice, lime-juice was not popular as a beverage on account of the mawkish taste which, as explained above, is so often carried with it."

As a medicinal agent in scurvy, lime-juice is very well known. It has also been extensively used in fevers, dyspepsia, gout, rheumatism, &c. It is shown in the pamphlet, from whence are obtained the foregoing abstracts, that it is compulsory for every ship to take on board a sufficient quantity of lime or lemon-juice to serve out so much per day to every member of the crew during the voyage, and thus, while either lime or lemon-juice is allowed in the merchant navy, the Admiralty are most particular to have only lime-juice, and that of the best quality, requiring a guarantee that it is gathered in certain months of the year, and thus the best, not only for citricity, but for flavour and condition. From the extended lime-tree plantations of Montserrat, an unlimited supply of lime-juice can now be obtained, so that the juice of the lemon might be altogether excluded.

Lime-juice is now prepared for market in various forms. First the juice, pure and simple, is sold in various sized bottles; secondly, a preparation known as lime-juice cordial, used for mixing with water as a refreshing or cooling drink; thirdly, a sort of lime-juice champagne" is described as the "purest, the most wholesome non-intoxicating drink in existence, especially adapted as a summer beverage, having all the appearance and 'bouquet' of good champagne without its intoxicating qualities;" and fourthly, lime-fruit-juice biscuits are manufactured.

CORRESPONDENCE.

PETROLEUM IN ROUMANIA.

According to a communication from Dr. Heinrich E. Ginth, published in the *Oesterreichische Monatschrift fur den Orient*, very extensive deposits of petroleum have been discovered on the eastern and southern slopes of the Transylvanian Carpathians, and as this may furnish a good field for British enterprise after the settlement of the Eastern question, I furnish an abstract of Dr. Ginth's report for the *Society of Arts Journal.*

1. *The Moldavian Petroleum Field.*—These occupy a surface of about 230,000 hectares (568,422 acres), forming a triangle, bounded by the rivers Tasleu and Trotusch, not far from the station Adschud, on the Roumanian Railway. The wells near Morneschti do not exceed 120 mètres (394 feet); those near Salante and Comonesti 50 to 70 mètres in depth. They are worked in a most primitive way. The proprietors of the land receive, instead of rent, one third of the gross produce. The cost of the petroleum at the well's mouth does not exceed four francs per 100 kilogrammes (220 lbs.) The wells are 25 kilometres ($15\frac{1}{2}$ miles) distant from the nearest railway station; but a line is to be built from Adschud to Tirgel-Okna, only 10 kilometres from the wells. The Moldavian petroleum is darker than that of Galicia, and since it remains fluid at a temperature of 20° Celsius (4 degrees Fahrenheit

under Zero) is well adapted for street-lighting. The specific gravity of the raw oil is 1·307, that of the distillate 0·742. According to Ginth's analysis, 1,000 parts of the raw oil contains:—

	Parts.
Illuminating oil, best quality	358
Ditto second „	301
Tar	176
Refuse	165
	1,000

At present about 7,000 barrels are filled in this district. The export of Moldavian petroleum to Austrian Galicia rose from 500 barrels in 1872 to 2,350 barrels in 1876.

2. *The Wallachian Petroleum District.*—This lies on the southern slopes of the Transylvanian Carpathians, and is more extensive than that of Moldavia. The wells are from 6 to 12 miles north of Plojeschti, a station on the Roumanian Railway. In Bakoni the inhabitants use the inflamable gas which issues from the ground to cook their meals. Steam pumps are not used. The manner of obtaining the oil is as primitive as that employed in Moldavia. The landlord receives a tenth of the net produce as rent for the wells. Part of the crude petroleum is refined at Sarati and Plojeschti; and part is sent by rail to Vienna, Pesth, and Odessa. A thousand parts of the crude oil contains:—

	Parts.
Illuminating oil best quality	400
Ditto second „	200
Paraffin	225
Refuse	175

When the Roumanian and Transylvanian Railways are connected by the line now being built from Kronstadt in Transylvania through the Tömäs pass to Plojeschti, there will be a large demand in Hungary and Austria for this crude petroleum, which is cheaper than that of Galicia, and is admitted into Austro-Hungary duty free, while American petroleum is subject to a heavy duty.

The immense extent of the Miocene formation in Wallachia justifies the hope that when the present rude processes are aided by those which have been so successful in Pennsylvania, the Roumanian oil-fields will become a source of wealth to the population. I am ready to give further particulars.

John Fretwell, Jun.

INDIAN COMMERCIAL PRODUCTS.—BAMBOO.

I am glad to see, from Mr. Begbie's letter in last week's *Journal*, that he appreciates the importance of the scheme I propose for utilising bamboo for "paper stock," and the facilities for carrying it out in British Burma. Although, however, Mr. Begbie fully agrees with the reports I have received of the unlimited supply of bamboo stems obtainable from the native forest, and that by the cheapest of all carriage, river transit, I am strongly of opinion that the system I have proposed, endorsed by Mr. Robert Thomson (in his letter published in the *Journal* of 1st March) a "regular plantation," possesses immense advantages over a desultory collection from the native forest, and this briefly for the following reasons—systematic planting of the most suitable variety of bamboo in a series of plots, in order to facilitate and economise cutting and carriage, it being understood that the plantation should be in proximity to the factory where the "stock" has to be produced, and said factory with easy access to port of shipment. It is also essential that the young shoots to be converted into "stock" should be cut at nearly the same period of growth, in order to ensure, as far as possible, regularity in the staple of the "stock" manufactured; hence the desirability of close supervision when collecting, and it is obvious that great economy in cutting, carrying, receiving, and storing so bulky a commodity as young bamboo stems would result from confining the zone of production, constituting, in fact, a large item of profit (or saving in cost) of itself.

I think, therefore, there can be little doubt that, as now obtains in the production of sugar, the factory and plantation should be in proximity to each other.

Thomas Routledge.

Claxheugh, Sunderland, April 23, 1878.

PLAGUES OF MICE.

In addition to the remarks of Mr. Colebrooke, I beg to send you the following extract from the *Globe*, which he has sent me, and which appears practical. There are swine in the infested districts of Asia Minor and Thessaly, kept by Christians.

Hyde Clarke.

A New Use for Pigs.

However valuable to the Irish peasant in paying the "rint" for the house which it shares with its master, the pig does not generally take very high rank in the farmer's estimation. Although in itself a profitable animal, the unpleasant habit which the pig has of ploughing up the grass fields into which it may be let out for a run, and of rooting up its habitation, would alone prevent its being a favourite with the grazier, even if the ease with which these animals may be kept by the cottager did not reduce their value in the eyes of the professional farmer. But it would seem that the sheep farmers, in certain parts of the world, at least, are likely to regard pigs with more favour, for it is announced from Germany that these unclean beasts have been turning their omnivorous tastes to good account by destroying field mice and other vermin, with which so many acres of pasture land have been overrun in Central Europe. It is suggested that the plagues of mice which have become so terrible a scourge in many parts of Germany and Austria are in great measure due to the practice of penning up the swine, instead of allowing them the range of the fields as formerly. The swineherd used to—and in certain parts of the Continent does even now—fill as important a position as our own shepherds, and it was customary to drive the herds of swine into the fields, to feed at random during the day; but this practice is far less common than it was, to which fact the abnormal increase of field mice is attributed. It is no unusual thing for a careful observer to detect pigs in the act of snapping up full-grown mice, while they have a special fancy for the nests containing young, for which they have a keen scent, and which they grub up and devour with avidity. The pig is well known to have a sense of smells which is easily trained, as is evidenced by the truffle-hunting pigs of Picardy; and it might, therefore, be worth the while of farmers in the mouse-infested districts of Scotland, to detail a few grunters for the special work of clearing off the tiny pests. It is curious, however, in view of the above view of the causes of the plagues of mice, that the same scourge should have appeared almost simultaneously in such widely separate districts as Scotland, Bohemia, Syria, and California, which are so differently situated in the matter of swine-herding.

With reference to "J. A. M.'s" letter, inserted in the *Journal* for April 19, I certainly gave the extract from the "Treasury of Natural History" correctly—viz., that the *Viverra genetta* belonged to the weasel tribe; but I agree with your correspondent in referring it to the *Viverridæ*, whereas the weasels come under *Mustelidæ*.

It is but right, however, to mention that *Viverra vulgaris* was applied by Starr to the weasel. (See Bell's "British Quadrupeds.") Mr. Wallace in his splendid

work, "Geographical Distribution of Animals," remarks, "The *Viverridæ* comprise a number of small and moderate-sized carnivorous animals, popularly known as civets, genets, and ichneumons, highly characteristic of the Ethiopian and Oriental regions.

"The extreme geographical limits of the family are marked by *Genetta* in France and Spain, *Viverra* in Shanghae and Batelian Island, and *Herpestes* in Java and the Cape of Good Hope." I may mention that the keeper of the civets in the Zoological Gardens lately pointed out to me two very fine genets (male and female).

John Colebrook.

17, Walton-place, Chelsea, S.W.
April 20.

NOTES ON BOOKS.

Stanford's Compendium of Geography and Travel (Africa).—Edited and extended by Keith Johnson. London: E. Stanford, 1878.

This work is based on Hellwald's "Die Erde und ihre völker," and, as appears from the preface, it is in fact a translation by Mr. Keane of that book, with additions by Mr. Keith Johnson, the original appearing, as was perhaps to be expected, to ignore to a considerable extent, or at least to fail to give a due share of credit to the labours of English explorers in a field which, by English geographers, is regarded almost as their peculiar province.

The book begins with a general introduction, treating and explaining some of the leading principles of physical geography. Then comes an introductory chapter on Africa, and after this the different divisions of the continent are treated in detail. The arrangement commences with the Atlas regions, Morocco, Algiers, Tunis, &c., thence travels South, taking the Sahara, Sudan, Upper Guinea, the Niger. After this follows Egypt, leading to the Red Sea Coast, Zanzibar, and the Equatorial Lake Regions Next, South Africa is treated, and following up the Western Coast we complete the survey of the continent. Two final chapters treat the islands—the West African Archipelagoes and the African islands in the Indian Ocean. Their is also an appendix on "The African races philologically classified." Throughout, the book is copiously illustrated with maps, diagrams, and woodcuts. In tho former, the results are given of the latest explorations. Amongst these perhaps may be noted the fact that the Congo, while still so named at its mouth, is re-christened the Livingstone for the chief part of its length.

OBITUARY.

Rev. James Booth, F.R.S.—Tho Rev. James Booth, LL.D., F.R.S., vicar of Stone, near Aylesbury, died on the 15th inst., at the age of 71. The eldest son of the late Mr. John Booth, he was born in the year 1814, and was educated at Trinity College, Dublin, where he obtained several prizes and graduated in honours. He was elected a Fellow of the Royal Society in 1846, and he contributed several memoirs and papers on mathematical subjects to the "Philosophical Transactions" and the "Philosophical Magazine." Dr. Booth became a member of the Society of Arts in 1852, and the same year he addressed a letter to the Council suggesting the publication of a weekly *Journal* in place of the weekly notices of proceedings then issued to members. This led to his appointment on a committee to consider the proposal, and on the retirement of Mr. Sidney Smirke, to his being invited to a seat on the Council. The report of the committee on Dr. Booth's proposition was favourable, and the first number of the *Journal* appeared on the 26th November, 1852. In 1855 he became Chairman of the Council. In 1856 he took a very active part in the establishment of the Society's examinations, and assisted materially in organising the system on which they were started, a system which was afterwards modified and developed by Mr. Harry Chester. He was also mainly instrumental in preparing the reports on "Middle-class Education," issued in 1857 by the Society, which were the results of one of the earliest movements in connection with technical education in this country. In the same year he annotated and edited, at the request of the Society, a volume of the "Speeches and Addresses of the late Prince Consort," published by the Society, and afterwards republished in a cheaper form for the use of skilled artisans and the middle classes. In 1859 he was presented to the living of Stone by the Royal Astronomical Society, to whom the advowson belongs.

GENERAL NOTES.

The New Patent Bill.—Locally, says *Engineering*, it is no secret that the Patent Reform Bill, which Mr. George Anderson, one of the members for Glasgow, has introduced into the House of Commons, is really of Glasgow origin, and that Sir William Thomson has had some share in drafting it. For the sake of persons in other parts of the country who may take an interest in Patent-law reform, it may be worth while to mention the following facts so as to show, by comparison, what Mr. Anderson's Bill proposes to do:—1. Under the existing law patents are granted for fourteen years, subject to the following payments, viz., £25 in four instalments within the first six months, £50 at the end of the third year, and £100 at the end of the seventh year. The new Bill provides that patents shall be granted for twenty-one years instead of fourteen, and at half the cost, viz., £12 10s. in four instalments within the first six months, £25 at the end of seven years, and £50 at the end of fourteen years. 2. Under the existing law, patents are occasionally, in meritorious cases, prolonged by her Majesty's Privy Council for periods of three to seven years beyond the fourteen, but the process is very expensive, costing in many cases from £200 to £300 sterling. Taking advantage of the principle already conceded, the new Bill makes provision for prolonging existing patents by the simple payment of a tax of £50 at the end of the fourteenth year. The Bill therefore contains three important clauses which *Engineering* thinks should recommend it to the consideration of both present and future patentees, and others interested in the improvement of our manufactures and the development of inventions.

The Water Supply of England.—Mr. C. E. de Rance, of her Majesty's Geological Survey, lately read a paper at Manchester, on "The Secondary Formation of England as a Source of Water Supply for Towns and Districts." He said that 15,000,000 of the British population lived in towns and cities, and, supposing them to be all supplied with waterworks, 12,000,000 of the rural population were deriving their water supply from shallow wells and flowing streams, almost always horribly polluted. Through the increase of population and manufacturing requirements, the quantity of water annually consumed in England was steadily increasing, while the number of available sources of supply being necessarily limited, the competition for the possession of suitable water-bearing areas, especially those adjoining the more densely crowded centres, became keener and keener, and the parliamentary and other preliminary expenses larger and larger. Rival townships, after severe competition, obtained the whole of the water rights of a district, to the exclusion of those who, from apathy or want of funds, neglected to claim a portion of the natural watershed due to them. The River Pollution Commissioners classified waters in the order of their excellence in respect of wholesomeness and palatability as follows:—Spring water, deep well water, and upland surface water, very wholesome; stored rain-water, surface water from cultivated land, suspicious; river water to which sewage got access and shallow well water, dangerous. Referring to

the scheme for obtaining a water supply for Manchester from the Lake District, he said if they could get a deep-lake basin like the Lake District, it would form a thoroughly good national supply. All they had to consider was that in drawing upon such a reservoir they should see that they only took such water as could be got from the rainfall of the district, and not draw upon the accumulated water of days gone by. From his knowledge of the water-bearing strata of England, he arrived at the conclusion that some 12,000,000 of their population lived in areas capable of being supplied with increased stores of pure water, contained in the permian, new red sandstone, the lower and great oolite, the greensand, and the chalk formation. In the case of the chalk in the valley of the Thames, great care should be taken in abstracting any large volume of water by means of deep wells from the underground springs, because of the fact that these maintained the steady dry-weather flow of the river, to which great damage might be done by any permanent lowering of the saturation line like that which had taken place from excessive pumping in the metropolitan area.

The Telephone.—A French inventor, Mr. Brégnet, has recently completed a so-called mercury telephone, which is quite a variation on the systems already in use. It is composed of two instruments for transmission and reception, connected by means of wires. Each of these consists of a glass vessel, containing acidulated water and mercury, into which is inserted a capillary tube filled with mercury. One wire connects the mercury in the tubes, and the other that in the vessels. When a person speaks before the transmitter, the vibrations of the air are communicated to the mercury, and cause variations in the electromotive force, which are transmitted to the receiver, and there give rise to vibrations of the air appreciable by the ear. A later simplification of the apparatus consists in using a tube with alternate drops of mercury and acidulated water, forming thus a series of electro-capillary elements.—*Nature.*

NOTICES.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at eight o'clock.

May 1.—"The Reforms in House Construction Demanded by Sanitary Science." By John Balburnie, Esq., M.A., M.D.

May 8.—"The Phonograph, or Talking Machine." By W. H. Preece, Esq. Mr. Alderman and Sheriff Nottage will preside.

May 15.—"Dietaries, in their Physiological, Practical, and Economic Aspects." By R. M. Gover, Esq., M.R.C.P., Lond.

May 22.—"Controlling and Connecting Clocks by Electricity." By Frederick J. Ritchie, Esq.

African Section.

Tuesday evenings, at Eight o'clock.

April 30.—"The Progress of Agriculture and Stock Farming in the Colony of Natal." By Peter C. Sutherland, Esq., M.D., Surveyor-General of the Colony. J. A. Froude, Esq., will preside.

May 28.—"A Year on the Nyassa, with Notes on the Slave Trade, and on the Prospects and Means of Opening up the Surrounding Country." By H. B. Cotterill, Esq.

Chemical Section.

Thursday evenings at eight o'clock.

May 9.—"Some Recent Improvements connected with Alkali Manufacture." By James Mactear, Esq.

May 23.—"The Position of Chemistry in a System of Technical Education, as illustrated by some of its applications." By J. M. Thomson, Esq., F.C.S., of King's College, London.

Indian Section.

Friday evenings at eight o'clock.

May 3.—"The Telegraph Routes between England and India." By Major Bateman-Champain, R.E. Lord William Hay, F.R.G.S., will preside.

May 17.—"Agriculture in India." By F. C. Danvers, Esq.

Cantor Lectures.

Monday Evenings, at Eight o'clock. The Third Course, for the present Session, will be on "Some Researches on Putrefactive Changes, and their Results in relation to the Preservation of Animal Substances." By B. W. Richardson, Esq., M.D., F.R.S. The Third Lecture will be delivered on Monday, May 6; the dates for the remaining Lectures will be as follows:—May 13, 20, 27.

Members can admit one friend to each lecture. Books of Tickets for the purpose were supplied to all the Members at the commencement of the Session.

MEETINGS FOR THE ENSUING WEEK.

Mon.... Institute of Actuaries, The Quadrangle, King's College, W.C., 7 p.m. Professor Pell, "The Institution of Actuaries' Life Tables."
Medical, 11, Chandos-street, W., 8 30 p m.
Zoological, 11, Hanover-sq., W, 1 p m. Annual Meeting.
Philosophical Club, Willis's-rooms, St. James's, S.W., 6 p m. Annual Meeting.

Tues. ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (African Section.) Dr P. C. Sutherland. "The Progress of Agriculture and Stock-farming in the Colony of Natal."
Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. T. Thistleton Dyer, "Some Points in Vegetable Morphology." (Lecture I.)
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Messrs. R T. Mallet, H. Lambert, and F. M Avern, "The Ravi, Alexandra, and Jhelum Bridges, Punjab Northern State Railway."
Anthropological Institution, 4, St. Martin's-place, W.C., 8 p m.

Wed.... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Dr. John Balbirnie, "The Reforms in House Construction demanded by Sanitary Science."
Meteorological, 25, Great George-street, S.W., 7 p m. Mr. A. D Michael, "New British Cheyleti."
Society for the Development of the Science of Education, United Westminster (Endowed) Schools, Alexandra-street, Victoria-street, S W., 7 30 p.m. Mr. R. E. H. Goffin, "Chemistry as a Factor in Education, illustrated by a Practical Lesson."
Archæological Institution, 16, New Burlington-street, W., 4½ p m. Annual Meeting.
Royal Institution, Albemarle-street, W., 2 p.m. Annual Meeting.

Thur....Chemical, Burlington House, W., 8 p m. Mr. Sidney H. Vines, "The Chemical Aspect of Vegetable Physiology."
Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Recital by Miss Heraud, "As you like it"
South London Photographic (at the House of the Society of Arts), 8 p m.
Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Colour." (Lecture I)

Fri...... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Indian Section) Major Bateman-Champain, "The Telegraph Routes Between England and India."
Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Mr. William Spottiswoode, "Polarised Light; a Nocturne in Black and Yellow"
Philological, University College, W C. 8 p.m. Mr. Alex. J. Ellis, "Report on the Present State of my Dialectal Investigations."

Sat..... Royal Institution, Albemarle-street, W., 3 p.m. Prof. Henry Morley, "Richard Steele." (Lecture I.)

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,328. Vol. XXVI.

FRIDAY, MAY 3, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

THE PHONOGRAPH.

On Wednesday next, the 8th May, when a paper on the Phonograph will be read by Mr. W. H. Preece, the first three rows of seats in the Meeting-room will be reserved for Members only, until ten minutes to eight o'clock by the clock in the Great Room.

EXPLOSIONS IN COAL MINES.

The publication of the Third and concluding Lecture on this subject, by Mr. T. Wills, has been deferred till next week. This has been rendered necessary by the pressure upon available space caused by the publication of the three Papers read last week before the Society.

NATIONAL WATER SUPPLY.

Committee.—Major-Gen. F. C. Cotton, R.E., C.S.I. (Chairman of the Council), W. Hawes, F.G.S. (Deputy-Chairman of the Council), F. Abel, C.B., F.R.S., Alexander H. Brown, M.P., James Caird, C.B., E. Chadwick, C.B., Lord Alfred Churchill, Hyde Clarke, Sir H. Cole, K.C.B., Capt. Douglas Galton, C.B., F.R.S., Sir U. J. Kay-Shuttleworth, Bart., M.P., R. W. Mylne, F.R.S., F.G.S., Admiral Sir Erasmus Ommanney, C.B., F.R.S., Prof. Ramsay, F.R.S., F.G.S., R. Rawlinson, C.B., T. R. Tufnell.

The Congress will be held on Tuesday and Wednesday, 21st and 22nd May, 1878, at 11 o'clock.

The object of the Congress is to discuss the question of a comprehensive scheme of National Water Supply, "with a view to the consideration of how far the great natural resources of the kingdom might, by some large and comprehensive scheme of a national character, adapted to the varying specialities and wants of districts, be turned to account, for the benefit, not merely of a few centres of population, but for the advantage of the general body of the nation at large," as suggested in the letter of H.R.H. the Prince of Wales, President of the Society, in which the subject was first brought to the notice of the Council of the Society.

Papers, prepared at the request of the Council, will be printed and circulated at the Congress, and discussion will be taken upon them.

HEALTH AND SEWAGE OF TOWNS.

Executive Committee.—Major-General F. C. Cotton, R.E., C.S.I. (Chairman of the Council), W. Hawes, F.G.S. (Deputy-Chairman of the Council), F. A. Abel, F.R.S., Lord Alfred Churchill, Sir Henry Cole, K.C.B., Col. Sir E. Du Cane, K.C.B., Capt. Douglas Galton, C.B., F.R.S., T. W. Keates, Dr. Voelcker, F.R.S.

The Conference on this subject will be held on Thursday and Friday, 23rd and 24th May, 1878, the Right Hon. James Stansfeld, M.P., late President of the Local Government Board, in the chair.

Programme of Proceedings.

The Conference will meet each day at 11 a.m., and will sit till 1.30, then adjourn till 2, and sit again till 5 p.m., and if necessary, meet again at 8 p.m.

Thursday, 11 a.m.—Opening of the Proceedings by the Chairman. Papers and discussions on—

1st. Public Health as Affected by various Treatments of Sewage.

2nd. Gradual Abolition of Cesspools and Middens, and Substitution of Tubs and Pails with speedy removal.

3rd. Whether any further Legislation, of a Compulsory or Permissive Character, is needed for bringing about a better Sanitary Condition of Towns or Dwellings.

4th. Progress, if any, made in the Utilisation of Excreta since the last Conference.

5th. Progress, if any, made in Treating Water-carried Sewage since the last Congress.

6th. Escape of Sewage-gas into Dwellings, and Modes of Prevention.

7th. Discharge of Sewage into Sea.

8th. Cost of Systems given in the last Report of the Local Government Board.

Friday, 11 a.m.—Proceedings will be resumed. Papers and discussions continued.

Papers on any of the above heads are requested.

There will be an Exhibition of Appliances connected with Sanitation and Water Supply. Manufacturers and others desiring to exhibit should communicate forthwith with the Secretary of the Society of Arts.

CHEMICAL SECTION.

Thursday, April 25th; Dr. Voelcker, F.R.S., in the chair.

The Paper read was—

THE PURIFICATION OF WATER.

By Gustav Bischof, F.C.S.

The subject which I have the honour to bring under your notice to-night, is of a somewhat embarrassing magnitude, though it is my intention to confine myself solely to the purification of water for sanitary purposes. It would be easy to lay before you a number of facts and conclusions bearing on the means by which this may be more or less effected, but it would be almost like building a house without foundations, were I not first to attempt an understanding between us, or, at least, to explain my views as to the nature of the work which a purifier of water has to perform.

Absolutely pure water, containing exclusively oxygen and hydrogen in the proportion in which they chemically combine to form water, is not known, even in our laboratories. The foreign matter in ordinary water is either gaseous, mineral, or organic.

The gases which generally occur in water, namely, free oxygen, nitrogen and carbonic anhydride, are, in moderate quantities, not only harmless but even desirable. Oxygen and carbonic anhydride render water sparkling and palatable. It is chiefly to them the so-called mineral waters owe their palatability, and they appear to have a beneficial effect upon the digestive organs. Other gases, such as sulphuretted hydrogen, indicate organic impurities and are objectionable.

Whether hard or soft water be more conducive to health has not been definitively settled, but probably a moderately hard water is more wholesome than either excessively hard or soft water.

Of greater consequence are the impurities of organic origin, consisting of living or dead animal or vegetable matter. These occur in water partially as solid particles in a state of suspension and partially in solution. Suspended impurities may be separated to a certain extent by mechanical filtration through sand, paper, or other materials. However, even in the brightest water, solid bodies are frequently discovered under the microscope, or by passing an electric ray through the water, as I will by-and-bye illustrate experimentally. These microscopic solid bodies are extremely minute in their largest sizes, the smaller objects remaining probably unseen, even by the aid of our most powerful microscopes. They are, therefore, not unfrequently considered amongst the matter which is in a state of solution. If these bodies are of an organised nature, we have in all probability to search amongst them for the virus which produces a number of the most disastrous diseases.

This naturally leads me to the germ theory. Whether and how far germs are at the root of disease, or whether the latter are due to common chemical agencies, is a much contested question. And yet it is a matter of considerable importance, upon which the decision hinges, whether we may depend upon the laws of chemistry in deciding any question relating to water supply, or whether this belongs more or less prominently to the physiologist. Being myself a believer in the germ theory, I wish to lay before you a few arguments, however incomplete they necessarily must be. We designate as contagia such parasitic infectious agencies as are transferable from one individual into the healthy body of another; there, we suppose, they multiply, when finding a favourable nidus, and produce a specific disease, similar to the one from which they originate, such as cholera or typhoid. What evidence, then, tends to demonstrate the organised nature of these contagia? They have never been with certainty isolated, no one has ever seen them, and yet, if we find that they are endowed with properties peculiar to living bodies, we can hardly evade the conclusion, that they themselves belong to a class of organisms. I think we shall agree that the property of producing their like by separation of part of their body and of growing by assimilation of extraneous matter, is peculiar to organised beings. Let us then, see whether contagia exhibit any evidence of such properties. Chauveau has proved experimentally that the virus of small-pox, sheep-pox, and glanders is independent of quantity. The minutest particle, such as can only be obtained by great dilution, produces the disease with apparently the same virulence as concentrated matter. The remarkable epidemic of typhoid at Lausanne (Switzerland) in 1872, is, on the other hand, a practical demonstration, amongst many others, that the virus of typhoid produces fearful results in a state of dilution, in which the deadliest of the known chemical poisons would, as a matter of certainty, have had no effect whatever. Is it not probable in the highest degree, that we have to account for that apparent independence from quantity by a power of reproduction and rapid self-multiplication?

Again, the direct connection between cholera or typhoid and preceding cases of the same disease, has in so many instances been traced as to justify in my opinion the conclusion that nobody has ever been attacked by either of them, unless the specific virus had been transferred to him originally from a person afflicted with the same disease. It is, of course, out of my power to substantiate this to-night, by detailing a great many instances, but I may suppose that most, if not all, of you are familiar with them. Such unvariable connection can scarcely be explained, except by assuming that the virus possesses the peculiarity of organised beings of self-reproduction, in other words, as Dr. Simon expresses it in one of his reports to the Privy Council, that contagia multiply, in case after case, their respective types, with a successivity as definite and identical as that of the highest order of animal or vegetable life. Indeed, unless we assume this, we cannot understand the constant relation to a parent case and the total absence of any *de novo* generation by chance or coincidence.

There are, further, numerous instances of epidemics which appear to prove almost to demonstration that the virus of typhoid is peculiarly virulent, when gaining access to our milk supply. Similarly we have reason to believe, that the virus is more active, when passed into water largely contaminated with organic matter, than when passed into comparatively pure water. This is at once explained, if we assume that the virus is capable of assimilating organic matter, in fact, of living upon it.

In cases of poisoning by known chemical agencies on the other hand, say, by lead, the poison is not transferable from person to person; and whenever certain conditions are given, such as water of a certain composition passing through

lead pipes, any person may, on drinking that water, be poisoned without any reference to a previous case. Small, but traceable, quantities of lead have frequently been found in the blood, liver, and other human organs, without any distinct injury to the system. Minute quantities of lead have sometimes been taken habitually for years, until the poison gradually accumulated to an extent sufficient to cause serious disorders, or even death. In his standard work on Hygiene, the late Dr. Parkes says with reference to this:—"On the whole it seems probable, that any quantity over 1-20th of a grain (of lead) per gallon should be considered dangerous." Such poisons therefore are not independent of quantity; on the contrary, let me also remind you, some of the strongest chemical poisons, such as strychnine, arsenic, lead, copper, and morphia, are given in small quantities as remedies against various ailments. Thus there appears to exist a sharp and remarkable contrast between ordinary chemical poison and the virus of cholera, typhoid, and similar diseases.

Dead organic matter forms a large proportion of ordinary filth, and all kind of filth is more or less liable to contaminate our water supplies. Those diseases, which are produced by common septic ferment, or by the ordinary putrefactive changes which dead organic matter undergoes, are therefore of peculiar interest to us.

As far back as about the middle of last century, Albrecht von Haller demonstrated that putrescent organic matter in aqueous solution may be fatal, if injected into the veins of animals. The symptoms he observed are, inflammation of the digestive organs, and disturbance of the nervous system. The animal heat is sometimes considerably increased, sometimes decreased. Panum succeeded in extracting a poison from putrid matter, which he describes as soluble in water, insoluble in alcohol, and free from albuminous matter. It is not destroyed at a boiling heat, and acts apparently like ordinary chemical poisons, the virulence being proportionate to the quantity injected. Arnold Hiller, on the other hand, has recently extracted an albuminous body from putrid meat by means of glycerine, which is precipitated and destroyed at a boiling heat, and soluble in alcohol and acids. On being injected under the skin of a rabbit, the extract, in which Hiller failed to discover any organisms, showed no effect for several days. Then, apparently after the ordinary period of incubation, the symptoms of blood poisoning made their appearance until the rabbit died. The poison was reproduced in the body of the animal, and by transferring it from rabbit to rabbit, Hiller calculated that in the tenth generation 1-120th of a drop of the original glycerine extract was sufficient to kill a rabbit in 52 hours. The symptoms were, fever, asthma, increased solution of the red blood corpuscles and diarrhœa. If Hiller's observation was conclusive as to the absence of organisms in the original extract, common chemical poison would appear capable of producing effects which I have endeavoured to show can only be attributed to living organisms. But I venture to suggest, that the absence of the lowest forms of organic life, or their germs, can, at the present time at least, be hardly proved conclusively, excepting by the absence of their ordinary visible effects, for there is certainly evidence of life beyond the power of our microscopes, and we cannot know what we might see if their magnifying power were increased ten or a hundred fold. The disastrous consequences which must be expected from the drinking of water, which is polluted by fermenting organic matter are, at any rate, illustrated by Hiller's experiments.

Upon what condition, then, does the wholesomeness of a water-supply depend? I cannot answer this by simply classifying the different sources of supply in one way or another, and laying down a rule that such and such sources are objectionable, or require purification, because those sources, which generally furnish an excellent supply, are sometimes contaminated and *vice versa*. But water must always be looked upon with the more suspicion the greater its liability to contamination by sewage, and more especially by human discharges, as these may carry with them the most dangerous specific seeds of disease. Thus, shallow well and river water are generally most largely polluted, whilst at the same time they are very extensively used for water supply. If we find these two attributes, namely, extensive use and pollution combined, it is worth our attention to inquire somewhat more closely into the alleged danger arising from the use of rivers and shallow wells as sources of water supply.

Rivers are generally largely fed by polluted surface water from cultivated land, and by vast volumes of sewage and other polluting waste materials. In the Registrar-General's returns we read from time to time that a variety of most disgusting matter may be traced in Thames water, not only at the intakes of the several water companies in London, but even after filtration through sand, although the water is then mostly free from disagreeable smell or taste. From this we see that we cannot rely upon the outward appearance, the brightness, palatability, or absence of colour and smell, in forming an opinion of the wholesomeness of a water.

The danger arising from the drinking of river water, especially in times of epidemics, is well illustrated by the experience of Glasgow. The mortality there, per 10,000 of population, during the three cholera epidemics of 1832, 1847, and 1854, was respectively, 140, 106, and 119, or, on the average, 122. During this period the water supply was derived exclusively, or almost exclusively, from the Clyde. Then followed the epidemic of 1866, after, in the meantime, the Loch Katrine water had been introduced. What was the result? The mortality from cholera decreased from the average of 122 to only 1·6, or to less than one and a half per cent. of that figure. There is no showing that this can be attributed to any other cause than the abandonment of the Clyde as a source of water supply.

Do not believe that this is an exceptional case. A glance at the map appended to the Sixth Report of the Rivers Pollution Commission will show the infinitely small area, which, excepting the Scotch Highlands, is covered by unpolluted river basins.

I have not been able to lay hold of any experimental proof in favour of the hypothesis of self-purification, of at least our English rivers, by oxidation; but in the Sixth Report of the Rivers Pollution Commission we find rather the reverse.

The dilution, to which sewage is being subjected in rivers, may be a safeguard, to some extent, against common filth; but if contagia be organised bodies or individuals, dilution offers, in all probability, no protection against propagation of disease by their agency. This, I think, must be followed from the experience gathered during the epidemic at Lausanne, to which I have already referred, and from other instances. It follows also, from a consideration of the extraordinary power of multiplication which, at any rate, some of the lowest forms of organic life exhibit. Thus, F. Cohn, a great authority on these matters, has calculated that one single bacterium might, within less than five days, fill up by its progeny the whole ocean, supposing they found a sufficiency of food.

The remarks about river water apply also more or less to shallow well water. A striking illustration of the dangerous character of this source of water supply was furnished by the epidemic of typhoid in Broad-street, London.

It is impossible, within the time at my disposal, to enter into any more particulars as to the different sources of water supply, but I wish to offer a few general observations on this point.

It is not sufficient that a water supply should be generally of a more or less satisfactory quality, nor that its average state should not give rise to any serious apprehensions. Otherwise, we would find ourselves unprepared and unprotected when the worst condition arrives, or when owing to the prevalence of epidemics, more than ordinary precaution should be required. In illustration of this, I believe that at ordinary times there is no actual danger in drinking, almost throughout the year, the water supplied from the Thames to the greater part of London, if it is sufficiently filtered through sand. This must be accepted in the face of the comparatively low mortality we have. But now and then, especially in times of floods, the water deteriorates, sometimes very seriously, and we even read of excremental matter being then traced in it under the microscope. This is certainly quite serious enough; but I ask you, is there any guarantee whatever that, should London be visited by an epidemic, our experience would be any better than that of Glasgow during the Clyde water period? It would, therefore, certainly be a great boon could we here have a water supply as pure as that from Loch Katrine; but, as long as this appears impracticable, we ought at least to have some additional means beyond those at present employed, of purifying Thames water during certain periods of the year, and during epidemics.

By-and-bye I will return to this point, but in the meantime let me direct your attention to some of the most prominent materials employed in the purification of water. Some have either exclusively or prominently a mechanical action, separating like a fine sieve the coarser particles of suspended matter; others act chemically upon the foreign mineral or organic matter, and reduce the latter more or less to harmless constituents.

The organic matter retained by mechanical purifiers must gradually undergo decomposition, and the water, in passing through them, takes up more or less of the decomposing matter. It is thus intelligible that such a water may, physiologically speaking, be impurer, and may be less wholesome, after than before filtration, should even chemical analysis indicate an improvement. To this class of materials belong mainly sand and wood charcoal, though the latter, for a very short time has also a slight chemical action. The more frequently the materials are changed, and the more they are aërated during filtration, the more perfect will be their purifying action.

With the exception of animal charcoal and spongy iron, I have not been able to lay hold of any conclusive evidence of the efficiency of the materials proposed as chemical purifiers. They both have been extensively used in domestic filters.

The success of any material used for domestic filtration largely depends upon the arrangement of the filters in which they are used. These should be as easily manageable, and as simple in construction, as is compatible with efficient working. In insisting upon the former, let us not overlook the latter portion of this sentence. The remark that absolutely pure water is not known, even in our laboratories, sufficiently explains that the purification of water is not a simple or easy operation, the efficient performance of which must be expected to give some little trouble. The easiest and simplest way is, after all, not to filter water at all, and it is but reasonable to expect that its purification should be in some ratio to the care we bestow upon it. We should, therefore, not be satisfied to leave the filter entirely to the care of servants, or even frequently without giving them any guidance how they are to manage it.

In all domestic filters easy access should be given to the user himself for cleaning and recharging, as it is indispensable that chemical purifiers should be renewed from time to time, and, as a rule, the more frequently they are renewed the better. Instead of the renewal, a cleansing of the material is sometimes recommended, by passing the water through the filter in the opposite direction to that ordinarily employed. By these means a passage may be opened for water through the filtering medium, however its pores had been clogged with filth, but the latter will never be removed efficiently. If any one doubts this, let me remind him of the difficulty which we find in keeping even the smooth surface of our slate cisterns in a clean condition. The slimy deposit adheres most tenaciously, and must adhere still more tenaciously to a granular, more or less porous, material. How often a material requires thus to be renewed, depends largely upon the energy of its chemical action upon organic matter.

If these considerations are conclusive, I must condemn all filters in which the materials are enclosed between slabs, which are cemented into the filter case; as this, by not giving access to the contents, encourages the undue prolongation of their use. From the same point of view, all materials are objectionable which, being in the form of porous slabs or balls, are not accessible throughout their mass. And, just in passing, let me warn you against the use of sponges, which, although excellent and convenient mechanical strainers, are truly a hotbed for the lower forms of organic life.

The water is passed through the materials mostly downwards, sometimes upwards, or laterally.

There are, of course, advantages and disadvantages incidental to each of these methods, but I believe that, by downward filtration, under otherwise like conditions, the most perfect purification is effected. The water, in passing through a granular material upwards or laterally, has a tendency to force a passage through certain channels, wherever it finds the least resistance, without being uniformly disseminated through the material. Another defect of upward filtration is that the deposit of any filth, which mostly collects where the water enters the material, is excluded from view, and even largely from our sense of smell, instead of being exposed and giving us warning. Downward filtration, whilst free from these disadvantages, renders filtering materials liable to choke, owing to their natural tendency to follow the course of the water.

A filter ought to yield as much water, in a given time, as can be efficiently purified by the material, necessitating some arrangement for accurately regulating the flow of water. This arrangement ought, preferably, to be independent from any compression of the filtering medium, as, by simple compression, a satisfactory regulation cannot practically be obtained, and should it even be obtained in the first instance, as the yield necessarily decreases at once as soon as any suspended matter is deposited from the water between the pores of the material.

The construction of domestic filters would, nevertheless, be comparatively easy, could one always depend upon a little common sense in their use. But it is necessary to guard, as far as possible, against ignorance and mischief, even at the risk of complication. A point frequently disregarded by the user is that portable filters should be placed in a cool locality, free from any vitiated air, and the filter taps ought to be situated as conveniently as possible, so as to encourage the use of filtered in preference to unfiltered water. If the unfiltered water supplying the filter be stored in cisterns, they should be kept clean, and have no connection with water-closets or drains.

These are the main points which have guided me in designing the different forms of spongy iron filters. The ordinary portable domestic filter consists of an inner, or spongy iron, vessel, resting in an outer case. The latter holds the "prepared sand," the regulator arrangement, and the receptacle for filtered water. The unfiltered water is, in this form of filter, mostly supplied from a bottle, which is inverted into the upper part of the inner vessel. After passing through the body of spongy iron, the water ascends through an overflow pipe. The object of this is to keep the spongy iron, when once wet, constantly under water, as otherwise, if alternately exposed to air and water, it is too rapidly oxidised.

On leaving the inner vessel the water contains a minute trace of iron in solution, as carbonate or ferrous hydrate, which is separated by the prepared sand underneath. This consists generally of three layers, namely, commencing from the top, of pyrolusite, sand, and gravel. The former oxidises the protocompounds of iron, rendering them insoluble, when they are mechanically retained by the sand underneath. Pyrolusite also has an oxidising action upon ammonia, converting it more or less into nitric acid.

The regulator arrangement is underneath the perforated bottom, on which the prepared sand rests. It consists of a tin tube, open at the inner, and closed by screw caps at its outer end. The tube is cemented water-tight into the outer case, and a solid partition under the perforated bottom referred to. It is provided with a perforation in its side, which forms the only communication between the upper part of the filter and the receptacle for filtered water. The flow of water is thus controlled by the size of such perforation. Should the perforation become choked, a wire brush may be introduced, after removing the screw cap and the tube cleaned. Thus, although the user has no access to the perforation allowing of his tampering with it, he has free access for cleaning. Another advantage of the regulator arrangement, is that, when first starting a filter, the materials may be rapidly washed without soiling the receptacle for filtered water. This is done by unscrewing the screw cap, when the water passes out through the outer opening of the tube, and not through the lateral perforation.

Various modifications had, of course, to be introduced into the construction of spongy iron filters, to suit a variety of requirements. Thus, when filters are supplied by a ball-cock from a constant supply, or from a cistern of sufficient capacity, the inner vessel is dispensed with, as the ball-cock secures the spongy iron remaining covered with water. This renders filters simpler and cheaper; and I incidentally remark that on this principle the larger sizes of filters, beyond portable domestic filters, are frequently constructed.

As the action of spongy iron is dependent upon its remaining covered with water, whilst the materials which are employed in perhaps all other filters lose their purifying action very soon, unless they are run dry from time to time, so as to expose them to the air, the former is peculiarly suited for cistern filters.

Cistern filters are frequently constructed with a top screwed on to the filter case, by means of a flange and bolts, a U-shaped pipe passing down from this top to near the bottom of the cistern. This tube sometimes supplies the unfiltered water, or in some filters carries off the filtered water, when upward filtration is employed. This plan is defective, because it practically gives no access to the materials; and unless the top is jointed perfectly tight, the unfiltered water, with upwards filtration, may be sucked in through the joint, without passing at all through the materials. This I remedied by loosely surrounding the filter case with a cylindrical mantle of zinc, which is closed at its top and open at the bottom. Supposing the filter case to be covered with water, and the mantle placed over the case, an air valve is then opened in the top of the mantle, when the air escapes, being replaced by water. After screwing the valve on again, the filter is supplied with water by the syphon action taking place between the mantle and filter case and the column of filtered water, which passes down from the bottom of the filter to the lower parts of the building. These filters are supplied with a regulator arrangement on the same principle as ordinary domestic filters. The washing of materials, on starting a filter, is easily accomplished by reversing two

stop-cocks, one leading to the regulator, the other to a waste-pipe.

Another form of filter has been specially adapted for the use on board ships, the splashing of water, or shifting of the materials, consequent to the rolling of the ship, being prevented by suitable arrangements.

For the requirements in India and other colonies, a filter had to be constructed combining lightness, easy and safe packing, easy management, and cheapness. In this there is no inner vessel, the spongy iron being kept covered with water by the joint action of two tin tubes, one sliding loosely over the other. The outer tube reaches from the top of the filter to a well with perforated sides, which rests on a watertight partition on the top of the receptacle for filtered water. The inner tube is closed at its base, reaching from the top of the spongy iron to some distance below the partition, through the centre of which it passes. Within the receptacle for filtered water this tube is provided with a regulator similar to the one in the ordinary domestic filter. Thus the water is made to pass through the filtering materials, which rest on the water-tight partition and the well, enters the latter, ascends between the two tubes, and descends through the inner tube, whence it passes through the regulator opening to the receptacle for filtered water. A perforated lid on the top of the materials is arranged to be tied down during transport, to prevent shifting of the contents.

Permit me now to explain briefly what spongy iron is, and to make a few suggestions as to its probable action as a purifier of water.

Spongy iron is metallic iron, which has been reduced from some oxide of iron without melting the product. I have tried various arrangements for the production of spongy iron, including the Siemens' revolving steel furnace, and believe that a reverberatory furnace of suitable construction is best adapted to the purpose. The weight of spongy iron is about 1 cwt. per cubic foot, or one quarter of that of ordinary iron which has been fused. Its more powerful purifying action, as compared with ordinary melted iron, is largely based on the fine state of division. But if we bear in mind certain properties of spongy platinum, we can easily understand that the difference is not solely due to the physical condition of the spongy material, which may have affinities differing from those of ordinary iron. This is at once indicated by its property of decomposing water without the presence of an acid. Spongy iron also reduces nitrates and the carbonaceous and nitrogenous organic matter. Whilst it thus appears to have essentially a reducing action, there are also indications of an oxidising process. Thus it appears that, under certain conditions, perhaps under the influence of some oxide, resulting from the gradual oxidation of the metallic iron, the ammonia may disappear entirely, being probably converted into nitric acid.

I need not explain to the members of the Chemical Section, that spongy iron is most energetic in precipitating any lead or copper, but even to chemists it is a remarkable fact, that it should reduce the temporary hardness of water very considerably, and the permanent hardness slightly. I cannot offer any explanation of the latter reaction, but the former, the reduction of the temporary hardness, is probably due to the affinity of the first product of oxidation, or ferrous hydrate, for the carbon anhydride, which is the solvent of the calcic carbonate. Ferrous carbonate is formed, and the calcic carbonate precipitated. From some reports, we shall presently see that this action was found to continue equally energetic for upwards of a year.

I have frequently been asked the question, what becomes of the organic impurities when filtering water through spongy iron. The reactions are of a complicated nature, and, up to the present moment, I can hardly give more than a few hints about them.

In two successive papers, one read before the Royal Society last year, the other recently, I have referred to a gas which I observed within the bulk of spongy iron, after it had been in use for some time. It is sometimes explosive, sometimes not. When ordinary water, such as that supplied by the New River Company, had been passed through a filter for several months, I found this gas to contain a hydro-carbon. On the contrary, when leaving spongy iron in contact with distilled water for an equal length of time, I failed to detect either carbon or hydrogen in the gas. This apparently demonstrates that the carbon in the former case was a product of the decomposition of organic matter.

It is likely that the nitrogen is, in the first instance at least, more or less converted into ammonia by filtration through spongy iron, but as ammonia is unquestionably at the same time produced in several other ways, I do not at present see how to furnish an experimental proof of that hypothesis.

Whether the ferrous hydrate formed by oxidation of the metallic iron has any decomposing action upon organic matter, is a question which I have not hitherto succeeded in answering. The final product of the oxidation is of course ferric hydrate. We know the destructive action of rust stains upon even such indestructible organic matter as linen and cotton fibres. It was, therefore, to be expected, that ferric hydrate should take an active part in the separation of organic matter from water. This led to the following experiments.

A glass bottle, tubulated at its base, was internally coated with a film of ferric hydrate, by filtering water through spongy iron, and then passing it into the bottle without previously separating the iron in solution. As soon as the bottle was nearly full, it was again emptied by a syphon arrangement, the soluble iron being thus oxidised and precipitated at the sides of the bottle. This was repeated until a sufficient deposit had been obtained, showing the characteristic appearance of ferric hydrate. The bottle thus prepared, after being filled with hay infusion, was stoppered, and left to stand for a couple of months, when the colour of the film gradually darkened. The bottle was then emptied, rinsed with water, and left exposed to the air. After about a fortnight, the coating almost regained its original yellowish-brown tint. It is thus evident that part of the oxygen had, in the first instance, been transferred from the ferric hydrate to the organic matter of the hay infusion. As any action would be much more energetic in the nascent state of the ferric

compound, it became of interest to study more closely the re-actions which take place when passing water through the spongy material.

A tubulated glass vessel was filled with spongy iron. On allowing water to pass through the vessel continuously for a few days, each granule appeared coated with ferric hydrate. However, on stopping the passage of water, the colour of the material, which remained covered with water, became soon darker, having, after a few days, almost its original appearance. I explain this by a reduction of the coating of ferric hydrate, by agency of the kernel of metallic iron in each granule, the product being some lower oxide, which in its turn is readily re-oxidised to ferric hydrate by the oxygen dissolved in water. Thus the spongy iron acts indirectly as the vehicle for conveying the atmospheric oxygen to organic matter, and this continues for a long time, as on the very top I found still a considerable proportion of metallic iron, after passing water continuously through spongy iron for upwards of ten months. Thus there are reducing and oxidising agencies constantly at work in the spongy iron filter, and the several oxides of iron are present in their nascent state.

In entering upon the chemical evidence of the efficiency of those agents which are employed or proposed as purifiers of water, I regret that there should be so little conclusive evidence concerning them, excepting as to animal charcoal and spongy iron. Whilst I cannot hesitate to lay before you the evidence of disinterested authorities, I am naturally reluctant to refer to my own experience in judging of the merits of other materials than spongy iron. There was lately a chance of enlarging our knowledge on this subject, when the Sanitary Institute of Great Britain arranged for a competitive examination of domestic filters, in connection with their exhibition at Leamington. Unfortunately, only a few of those invited thought fit to submit their filters to the trial, those represented comprising animal charcoal, the peculiar shale which is employed in some filters, and spongy iron. The committee appointed by the institute to test the purifying power and other merits of the several filters consisted of Dr. Bostock Hill, of Birmingham, county analyst; Dr. George Wilson, of Leamington, medical officer of health; and Professor Cameron, of Dublin. You are probably aware that the award "for general excellence" of the institute's medal was made to the spongy iron filter.

Important evidence on the same subject, though also incomplete, owing to the unwillingness of most manufacturers to submit their filters, is to be found in the Sixth Report of the Rivers Pollution Commission, "On the Domestic Water Supply of Great Britain." There we find the result of fifteen pairs of analyses of Thames water, before and after filtration through spongy iron, the testing being repeated about every fortnight. On comparing the average result of the two last pairs of samples with that of all samples, we find that, after the filter had been in constant action for upwards of eight months, the reduction of the important nitrogenous organic matter and of the hardness was still continuing.

I may take it for granted that the conclusions which have been drawn in the report from these analyses are known to you; they would, without doubt, have been still more satisfactory had not the spongy iron filter experimented upon been one of the very first ever made. Thus, it was of a somewhat crude construction, not provided with the regulator, which has now become a feature of the filter; thus I account for a certain irregularity in the analytical results.

Now, in the same report, there is also exhaustive evidence as to the merits of animal charcoal as a purifier of water. It is demonstrated, and I think we all are aware of this fact, that fresh animal charcoal removes not only a large proportion of the organic impurity, but also of the mineral matter. However, the report tells us the reduction of the hardness ceases in about a fortnight, the removal of organic matter continuing even after six months, though to a much less extent, especially if the filter be much used. For this reason it was found necessary to renew the charcoal every six months, when used for the filtration of the comparatively pure water of the New River Company; whilst the water which is supplied from the Thames requires the renewal of the charcoal every three months. Unless this be done, we are told that myriads of minute worms are developed in the material, passing out with the filtered water. This statement sufficiently explains the final conclusion, that the property of animal charcoal of favouring the growth of the low forms of organic life, is a serious drawback to its use as a filtering medium for potable waters.

The chemical part of this evidence is more than corroborated by Mr. Byrne's experiments. He stated, in a paper read before the Institution of Civil Engineers in 1867, that, on passing 12 gallons of moderately impure water through animal charcoal, over 55 per cent. of the organic matters were removed from the first gallon, but that this declined so rapidly that, at the eighth gallon, organic matter was given back to the water. In the debate on Mr. Byrne's paper, Mr. Chapman stated that he actually recovered from the charcoal the amount of organic matter which had been previously removed by it from a water. If we compare these statements with others which are more favourable to charcoal, we must, I think, conclude that, under certain conditions, which are as yet not thoroughly understood, it appears capable of giving more satisfactory results. Probably this depends largely upon the thorough burning, without alteration, of the physical structure.

But, granted that there are no remains of half-charred flesh or fat in the charcoal filter; that all organic matter has been destroyed by burning; even then we can explain the physiological results referred to in the report, namely, the liability of favouring the growth of the low forms of organic life. An intimate connection appears to exist between these and phosphorus, as is clearly demonstrated by the microscopic water test which has been proposed by Mr. Heisch. If a minute quantity of cane sugar be added to ordinary water, low organisms are developed in such enormous numbers as to cause, in about 24 hours, an opalescence, or milkiness. Dr. Frankland has demonstrated that this is wholly or partially due to the minute trace of phosphorus contained in sugar, as he obtained a similar result by adding a variety of compounds of phosphorus instead of sugar. Is it then astonishing that animal charcoal, containing some 75 per cent. of calcic phos-

phate, which is by no means insoluble in water, should produce a like effect?

If I have succeeded in demonstrating that fermenting organic matter is amongst the most objectionable impurities in water, the preceding suggestions are worth our fullest attention, as the milkiness produced in water by sugar is unquestionably due to fermentation. But the objection to the use of animal charcoal as a filtering medium for potable water becomes still more serious, if we assume that some of the most disastrous epidemic diseases are produced by low forms of organic life. Can we, in this case, *à priori*, maintain, that their growth may not also be favoured by animal charcoal? Chemical analysis is incompetent to deal with this question, for the living matter in water is by weight always insignificant, as compared with the dead organic matter. Analysis may, therefore, show, after filtration, a considerable reduction of the total organic matter, and yet those living bodies may have enormously increased.

May I, in further support of this important point, refer you to my researches, which you will find in the proceedings of the Royal Society? With a view of testing the purifying action of spongy iron physiologically, I left meat in contact for many months with ordinary water, or even hay infusion, both having been filtered through spongy iron. The meat remained fresh throughout, if no putrefactive agents had access to it, excepting those that might have passed with the water or hay infusion through the filtering medium. Putrefactive agents were, therefore, absent from the filtered liquids. But on filtering the same kind of water as before, under otherwise precisely like conditions, through animal charcoal, the meat was putrid after a short time. It would of course have been useless to extend the latter experiment to hay infusion.

From these results we may draw important practical conclusions. Fermentation or putrefaction are some of the most powerful agents in destroying organic matter by converting it into a number of gaseous and other constituents. If such fermentation be constantly at work within a filtering medium, we can understand what becomes of the organic matter, should it even be only mechanically retained in a filter. But this is different in the spongy iron filter, looking at the preceding results. Putrefaction being unable to effect the elimination of organic impurities, they must either accumulate or be got rid of by some such chemical agency as before suggested. A constant accumulation would necessarily soon result in a contamination of the filtered water, the latter taking up organic matter from the filtering medium, as we found it stated in the case of animal charcoal. This being contrary to all evidence, we must conclude that no such accumulation takes place, but that the organic impurities are destroyed and rendered innocuous in the spongy iron filter, by at least as powerful chemical agents as fermentation and putrefaction.

You are probably acquainted with the three reports in the Registrar-General's returns for 1876, 1877, and 1878, on the spongy iron filter, and I might pass them over, did I not wish to draw your attention to the interesting result recorded in the report for 1877, that even in times of flood, when the Thames was unusually loaded with organic impurities of the most disgusting origin, its water was, after filtration through spongy iron, purified to such an extent as to surpass the Kent water, which, from its freedom from organic contamination, is justly considered the standard of purity. The organic carbon in the filtered Thames water was ·038 in 100,000 parts, that in the Kent water ·048. Both were equally free from organic nitrogen, but the hardness of the filtered Thames water was less than one-third that of the Kent water. The filter had previously been in use for more than a year without change of materials. The ammonia in the filtered water was increased to ·010. Referring to the correspondence on this subject in the early numbers of the *Chemical News* during the present year, I maintain, that we cannot draw from the presence of ammonia in such filtered water any inference, which might be more or less justified when analysing a natural water that has not undergone any such artificial treatment.

By direction of the Under-Secretary for War, a trial of filters was commenced at the Army Medical School, Netley, by the late Dr. Parkes, and completed about two years later by Dr. de Chaumont. It was found that of all filters experimented upon, the spongy iron filter alone yielded water in which no living or moving organisms could be detected under the microscope.

A report strongly recommending spongy iron has also been recently made to the Prussian War Minister by the military authorities at Coblenz. It is based upon experience with a large filter during an epidemic of typhoid amongst the garrison. A copy of the report has been promised to me, but as yet I have not received it.

Lastly, a report was made at the Somerset-house laboratory by request of the Secretary for India, which is throughout in favour of the spongy-iron filter.

I have devoted so much time to domestic purification of water, because, as a rule, it is more effective than that on a large scale before delivery of the water to the consumer. This hardly requires an explanation. Look at our city. Its daily requirement of water, in round figures, is 120 million gallons. Such an enormous quantity is not easily dealt with, moreover, only a small proportion is used for drinking and cooking. This consideration has lately led to the proposal of two distinct water supplies, one for drinking and cooking, and an other for general use. We then might either have derived the former supply from unexceptionally pure sources, or we might have bestowed so much more care and expense upon the purification of the potable water. But although this apparently would have been a satisfactory solution of the question, I am afraid it is fraught with great difficulties indeed.

If that scheme had ever been carried out, the present water supply would, almost as a matter of necessity, have been neglected, as its purity for flushing and the like is of no great consequence. The quantity of water for drinking and cooking allotted to each consumer by the provisions of the scheme was very liberal; but suppose the supply of pure water had ever failed, what would have been the consequence? Again, I do not see how any householder could possibly have been prevented from

using three or four times the quantity of pure water he was entitled to. The result must have been inevitably an insufficiency elsewhere. Now, in these cases, and if by negligence or obstinacy of servants the impure water were used for drinking, it would have been a most serious matter had our present supply deteriorated.

In view of the difficulty of purifying the whole water supply, or of branching off a separate supply for internal use, we would at once dismiss purification on the large scale as undesirable, and confine ourselves to domestic filtration, if not there again we found most serious objections. We cannot expect, for the present at least, to reach with domestic filtration the poorer classes; and we have not only an interest in their welfare as our "neighbours," but we are personally interested in it. However careful we may be to exclude disease from our houses, by providing a wholesome water, disease may be spread to them from the houses of the poor.

This leads me to a practical suggestion. I take it for granted that in London, and the same holds good in many other localities, careful filtration through sand is sufficient almost throughout the year. Why, then, should not additional means of purification, say through spongy iron, or any other medium that may be found preferable, be held in readiness, to be used only in emergencies, such as floods, or during periods of epidemics? The same spongy iron might thus be made to last at least five or six times longer than when continuously used, and the working expenses would be so considerably reduced as to become insignificant. I believe, that, with an efficient supervision of the water supply, this proposal might work very well, offering all reasonable guarantees.

A water which has never been polluted would certainly be preferable to one which, after contamination, is re-purified. But where is, with rare exceptions, water to be found which has never been polluted? Deep-well waters and even spring waters are unquestionably more or less supplied by polluted surface water, which is purified by natural filtration. If analysis, if the microscope, prove that artificial filtration is equally or even more effective, if the physiological character of both waters should prove the same, we may, I think, as safely rely upon artificial as upon natural filtration, and more so upon the former, as the naturally purified water may fail, whilst artificial filtration may be carried out to almost any extent.

After the reading of the paper, several illustrative experiments were shown. The electric ray was first passed through ordinary air, and by interposing a bolt-head, filled with purified air, it was shown that the luminosity of the ray is due to the solid particles floating in our atmosphere. The probability that these particles consist chiefly of organic matter, was demonstrated by burning air, through which the ray was being passed, with the flame of a Bunsen burner. The zone thus burned ceased to be luminous. The conclusion at which Dr. Tyndall arrived, that certain infections do not take place, unless the air supports the luminosity of the ray, was then applied to several samples of water, the difference being shown, when passing the ray through dilute sewage, through Thames water, as delivered by the Grand Junction Company, before and after purification by spongy iron, and, finally, through Kent water.

DISCUSSION.

The Chairman, in inviting discussion, said he hoped it would take a chemical turn, especially as he saw gentlemen present who had had some experience with different filtering agents, and who might be able to throw some light on the peculiar action of spongy iron.

Dr. Bartlett said the remark of the Chairman, in asking those present to confine their remarks to the chemical aspect of the matter, was one which had occurred to him as most apposite to the section. He must say that he had been somewhat disappointed, inasmuch as the lecture appeared to be directed more in the interest of filter-makers than as bearing on the chemical relations of the subject which the Chemical Section should deal with. He came for instruction, because so many alterations had taken place in the programme put forward by those who had advocated filtration through spongy iron, that he anticipated some of the first objections which were made to that system would have been alluded to. For instance, Mr. Bischof had contrasted the efficacy of spongy iron with animal charcoal, but he remembered that when the spongy iron filter was brought out many years ago, charcoal in one form or another formed almost an integral portion of the system. The use of spongy iron was supposed to oxidise, decompose, putrify, or ferment out the organic matters with which water is understood to be contaminated, after which charcoal of some kind, or common chalk was used to filter out the spongy iron which had been taken up by the water. Now, they were led to believe in the entire and perfect efficiency of spongy iron in its oxidation, putrefaction, or fermentation, by which accumulations of organic or decomposing matter were got rid of, and the water, having passed through the required stratum of spongy iron, was utilised after passing through some prepared sand, the composition of which had not been thoroughly explained. He did not deny that many of those actions took place, but, on the other hand, he had difficulty in understanding how far the decomposition—he would not say whether fermentation or putrefaction—would get rid of organic matter. He had great difficulty as a chemist in understanding how it got rid of ammonia—how it could exist in combination with this spongy iron, or how it was got rid of afterwards. He had in his pocket a small cutting from the *Daily Chronicle*, in which he found that the clerk to the Board of Guardians, at the offices in Bartholomew-close, stated that the water supplied by the well at Bow (which he believed was used for the workhouse at Homerton), was turbid, with a bluish green tint, when examined in large bulk, and was free from objectionable taste or odour. The total solid matter was 38·8 grains per gallon, and the degree of hardness 26·6, reduced by boiling to 11. This was considerable, and rendered it not well suited for ordinary detergent purposes. Then, the analyst went on to say there was nothing in the water which led him to form an adverse opinion with regard to it as a drinking water, but ammonia was present in a large quantity. It contained a large quantity of magnesia, but although he did not not regard it as a first-class drinking water, he did not think it otherwise than wholesome. When he found this was the analysis of a water which was being largely consumed, he asked himself how would Mr. Bischof consider he was dealing with it through this spongy iron. In the first place he said the hardness was considerably diminished by passing through spongy iron, and he wanted to know in what way that hardness disappeared. Organic matter might be got rid of by putrefaction or fermentation, but he had yet to learn how the solid matter of 38 grains per gallon could be disposed of. If the filter was used for two years at the rate of one gallon per day, it would require to get rid of 2 lbs. weigh of these solid matters, most of which were, no doub

carbonate of lime and carbonate or sulphate of magnesia. Then he should like to know what became of the large uantity of ammonia, and if he considered that that rendered the water unwholesome; and if so, how did he get rid of it. Next, if it had been found necessary or advisable, in the first instance, to use charcoal, whether animal or vegetable, for the purpose of getting rid of the iron, which he admitted still remained in suspension or dissolved in the water, how had he been able to eliminate it, and had he been able to dispense with chalk or charcoal, so that a few inches of sand and gravel was adequate to the removal of those matters. The outcome of all these investigations ought to be of a practical nature. He was quite convinced that a large amount of action did occur, both by oxidation, fermentation, and a variety of other means, in getting rid of organic matter; but he was by no means certain that the entire action could be secured so that no excess of it should go beyond the filter; and the point he wished to be certain of was that they should not be continuing that process of fermentation of organic matter, after their systems became the filtering media of the water, which had been already filtered in the way spoken of.

Mr. Thorp did not quite agree with Mr. Bischof, that domestic filtration was more effective than that on a large scale before the delivery of the water to the consumer. This was a matter which depended almost entirely on the care with which the domestic filter was treated. He approached this matter quite impartially, for he did not possess a single filter, seeing that the water he had supplied to him was, he considered, sufficiently filtered by the company, and he fancied that a domestic filter was often a source of danger, and very apt to break down at unexpected moments. The filtering applied to the different supplies of water in London varied very much. Some companies with large storage reservoirs, such as the West Middlesex, carried on their filtration very slowly, and got an exceedingly good result, whilst others, which had but small storage capacity, had to effect their filtration at a much greater rate, and, consequently, it was not so efficacious. He was a little disappointed that Mr. Bischof seemed to neglect what was to him a fundamental consideration, namely, the quantity of oxygen dissolved in the water filtered. He divided filtration into two classes: one in which it was purely mechanical, in which the materials removed remained in their original condition without undergoing chemical change; and the remaining cases where a chemical change was produced. If you filtered sewage through any material, you got whatever material was removed in pretty much the condition in which it previously existed, simply because it was, in most cases, free from oxygen, and no oxidation could take place; but it was a thing you could not do for any length of time. After a great many experiments, he always observed that the filter speedily became choked, and the removal of putrid matter was entirely stopped. Filtration, where chemical change took place, might again be divided into classes: one, in which the water contained enough oxygen to remove and burn up the organic matter; and the other, in which that supply of oxygen was insufficient, and then the filter, for the most part, tended to stop by choking; or to avoid that you must lay the material dry so as to allow the entrance of air into the pores. This, of course, was sometimes done, but in most cases of ordinary town supplies, the quantity of oxygen present was sufficient to effect the desired purification. Then, if the water was passed through the material, whether it were sand, animal charcoal, or spongy iron, and was not passed too quickly, he did not see why the action of the filtration should not be perfectly and indefinitely continuous, and in that case no slimy matter would be deposited within the filter. He thought it highly important that this question of aëration should be fully considered, and the rate of filtration so adjusted as to keep the work it had to do fairly within the powers of the filter, in the way of bringing about a combination between the dissolved oxygen and the organic matter. To put it in a homely way, he would suggest that the filtering material acted somewhat as a master of the ceremonies in introducing the oxygen to the organic matter, and if the filtration were not too rapid he thought this would go on indefinitely. Occupying the position he did under the late Royal Commission on the Pollution of Rivers, he had had the whole of the experiments made in their laboratory under his care, so that he had had an opportunity of watching this filter for a long period, and it certainly did its work extremely well. He had also seen a good deal of work done in the same place with animal charcoal, and that also gave extremely good results, but of course in both cases the filtration required care; and he must again say, in conclusion, that he preferred to have the filtration conducted on a large scale rather than in the house.

Mr. J. Death said, a short time since, a correspondence on the question of ammonia in filtered water took place in the *Chemical News*, and he there gave a few of the results of his own experience. He was neither directly nor indirectly connected with any filter company, his experiments having been conducted principally with a view to aid brewers. His experiments on spongy iron, and on another filtering medium which he would not mention, showed that the former, which he should call a reducing filtering medium, had an especial action on organic nitrogen, whilst filters with an oxidising action, and which acted by catalysis, such as animal charcoal, sand, &c., had a special effect on the removal of organic carbon. These views had been fully borne out by some experiments which he was still pursuing, and he could not, therefore, go into the thing very fully; but he wished to remark that these filters had their analogies in nature. The sixth report of the Rivers Pollution Commission showed that water from porous strata, such as the new red sandstone, contained 3·12 parts of carbon to 1 of nitrogen; from the chalk the ratio was 3·86 to 1; and from the oolite 3·96 to 1. These are well-aërated and porous filtering media, and might be called "oxidising strata." Then came other strata in which were often found sulphuretted hydrogen, such as the greensands, the London clay, and carboniferous strata. The ratios of organic carbon to nitrogen were, in the greensand, 6·15; the London clay, 5·65; and the carboniferous, 4·51. Such water could not contain oxygen, and he called the strata "reducing strata." The most porous strata, and which were oxidising, all contained very little carbon in proportion to nitrogen, whilst the reducing strata contained a great deal of carbon, and comparatively very little nitrogen, therefore, he divided them into those two classes. Those figures only related to deep well-water, but spring-water did not come under the same category. When water first entered the earth a little oxidation took place, because there was dissolved oxygen, and when it came up as in a spring there was another oxidation, so that in deep wells only you obtained the necessary conditions. The spongy iron was a reducing filter, and he was not aware of any other, all the other commercial filters being oxidising. The following was one of the analyses of water he had made bearing on this subject:—

Results expressed in parts per 100,000.

	Unfiltered.	Oxidising Filter.	Reducing Filter.
Ammonia	·001	·006	0·075
Organic carbon	0·289	·027	0·040
Organic nitrogen	0·036	·012	0·003

Thus it would be seen that the carbon left in the water from the oxidising filter was very low, as was the nitrogen in the reducing filter. He believed there was a little iron in the oxidising filter, but in what state he did not know. We might, therefore, assume that in oxidising filters the carbon was easily removed by direct oxidation,

but the nitrogen was not removed so quickly. In reducing filters, there was the nascent hydrogen acting in the formation of ammonia, but what became of the carbon, that was the question he wished to ask Mr. Bischof? All the speakers had attributed its removal to the atmospheric oxygen dissolved in the water, and to some extent that was true; but if you had the free oxygen all dissolved away, which in reducing strata would be very soon, because the sulphuretted hydrogen would take it up, where were you to get oxygen from? That problem had never yet been solved. His idea was that the organic matter in the organic oxygen contained a part of its own purification, that part of the organic oxygen united with the carbon to form carbonic acid, a part of the organic oxygen went to form oxide of iron, and the nitrogen united with the hydrogen to make ammonia. This was a theory of his own, and it was very difficult to prove, but he was experimenting to elucidate the question if he could. Nitrogen of vegetable origin was removed with very great difficulty. From some experiments he had made, it appeared that oxidising and reducing filters reduced vegetable nitrogen in about the same amount. Mr. Bischof's idea of alternating oxidation and reduction seemed very feasible, and that to some extent accounted for the removal of organic carbon.

Mr. Wanklyn thought there was a great difficulty in accepting the explanation just offered. One of the most advantageous cases which could be selected for the theory would be the case of sugar, but if you inserted the calculated quantity of oxygen required to oxidise the sugar, so that the carbon might appear as carbonic acid, it would be found that you required more than its own weight of oxygen. Therefore he did not think chemists would regard this as at all a tenable explanation. He had been much gratified at hearing Mr. Thorp's idea of the action of filtration, that it consisted in the conveying of the oxygen dissolved by the water to the organic matter by the intervention of the filter, and that all water which any one would ever think of purifying contained sufficient oxygen in solution for that purpose. That was the view he had held for many years, and was distinctly put forward in some papers he wrote for the *Chemical News* some time ago, when speaking of the silicated carbon filter. The material of which it was made was a kind of platinum black, which caused the organic substances to be oxidised by the oxygen dissolved in the water. He had experimented on filters at different times for the last 11 years, and he believed the late Mr. Chapman, Mr. Smith, and himself, were the first to point out that filtration was something more than a mechanical process; that the passage through these thick porous media had more than a mechanical operation. The filter-makers all maintained that it was so, but the chemists insisted that they were quite wrong; but it turned out, after all, that the filter-makers were right. In the year 1867, one of the first things Mr. Chapman, Mr. Smith, and himself did, when they got hold of the ammonia process, was to show the means of purification which was used by a good Thames water company. They went up the Thames, and took the water where the companies drew it, and then made analyses of the water supplied in London; and found that, from the latter, three-fourths or five-sixths of the organic matter had disappeared. Since then he had operated on all kinds of dirty water containing animal and vegetable matter, and his experience was that such a filter as a silicated carbon filter removed those materials completely. So that starting with very dirty water he could turn out water equal to the finest spring water in organic purity. The action of the filter was double. First, the material was fixed to the filter. If the water passed through contained no free ammonia to begin with, it would first pass without free ammonia. After a while, it would contain free ammonia, and would contain no organic matter. The organic matter was fixed to the filter in the first instance, and then oxidised by the oxygen dissolved by the water. He had experimented on various filters, spongy iron amongst them, and he did not find that it acted better than others; in fact, it was much slower in its action than the silicated carbon. Both removed organic matter, but although he had not the exact figures with him, he believed he was not exaggerating in saying that the silicated carbon filter would act at about 100 times the rate of the spongy iron.

Mr. Spencer said he had never seen the so-called spongy iron until the previous day, but he found it was iron and only iron. They all knew that spongy platinum had properties different from those of the solid metal itself, and he began to imagine that there was something in the spongy iron that purified the water. For this reason, in 1857, Dr. Medlock brought out a patent for purifying water with iron, and he used iron filings, scrap iron, and so on, but he used precisely the same thing in a different form that he supposed Mr. Bischof now claimed as an invention. It was quite true that iron did purify water as far as organic matter went, for at that time he examined the process for some of the London companies, and it certainly did throw down the organic matter, but it rusted while doing so. There had been a great deal of theory with regard to the action, but nothing very satisfactory was arrived at further than this, that when the iron oxidised in the water, the water was decomposed, and nascent hydrogen was liberated. They all knew that nascent hydrogen had peculiar qualities, which hydrogen not nascent had not. and it introduced a combination—which might be catalytic, and he believed it was—with the organic matter and the oxide of iron. But be this as it may, the purification was not of the most agreeable character, and the water had to be treated afterwards somewhat as Mr. Bischof did, for he was obliged to filter it after passing through the spongy iron, and this was found to be a great objection to the adoption of the principle on a large scale by the water companies; in fact, the water would have been made chalybeate. He found on inquiry that the spongy iron filter-makers expected to have their filters renewed at least once in 12 months, and sold the material for the purpose. If there were any phosphates in the iron, or any other impurities, which iron generally contained, the water would take up a little of it, though that might not be of much importance. With regard to the experiment shown, Mr. Bischof said that when the electric light was passed through the filtered water it gave what he might call a better ray than through the unfiltered water, and that this was due to the absence of organic matter; but that was, to some extent, a question of theory. He said the spongy iron softened the water, and, no doubt, a portion of the salts of lime and magnesia were taken out, and it was more owing to that, than to the absence of organic matter, that the effect was produced, for he had seen water treated in the same way with a large amount of organic matter, which also presented a good appearance. Again, with regard to softening water. He always said it would be a very unfortunate thing for filter-makers if their filters did soften the water, for they would not be in action for 24 hours, especially if the water were very hard, because they would get stopped up immediately. Another important point was that hardness was necessary for health. A great deal was said about the death-rate of towns supplied with soft water, and it was no doubt higher than in towns supplied with hard water. But there was a fanaticism about this, especially in the north, where soft water was in great demand for manufacturing purposes, and wherever they were told of an increased death-rate they always put it down to drainage, and never to the soft water. This was a mischievous idea, and there was an attempt even in London and in Manchester to get soft water for drinking. It might be very well for manufacturing purposes, but for the supply of a town population he said decidedly there was not a more beautiful water supply to any town on the Continent or even in America than the supply in London. He did

not say it ought not to be purified both mechanically and chemically, but it was very mischievous to run down this most wholesome of all waters. He would not say anything about rival filters, but would only repeat that the iron process was not new, and without another material being used the water would not be drinkable.

The Chairman said it was now so late that he would not enter into the question of the relative purity of the water of different companies, but all who had given attention to the supply of water would agree with him that, while our large towns were at present well supplied with good wholesome water—thanks to the exertions which had been made to compel companies to filter their water properly—there was frequently in the country very bad water, so bad that it could not be properly purified by simple filtration. Therefore domestic filtration appeared to him perhaps not quite so useless as Mr. Thorp was inclined to consider it; and even in large towns where they had not a constant water supply, but were obliged to store the water, though it might be delivered pure, it got contaminated in the cistern, and even in the better houses in the West-end of London it was found that organic filth accumulated in those cisterns, and by degrees made the water unwholesome, and, in fact, disgusting. In the case of contagious disease prevailing, it would, of course, be positively injurious to health. Domestic filtration was therefore a safeguard even where the water was delivered pure. Quite recently he had examined a great many waters supplied from cisterns, and his experience was decidedly favourable to the use of domestic filtration as a safeguard; and even if he had to use the Kent water, if it were stored in a cistern, he should take the precaution to pass it through a filter. He wished, on that occasion, to occupy quite an impartial position, and not to speak unfavourably of one filter or another, but he perfectly agreed with what had fallen from Mr. Thorp and Mr. Wanklyn, that filtration was essentially an oxidising process, that a good filter ought to possess the property of removing the organic matters, and that thefiltering medium acted just like spongy platinum or any other porous material, such as charcoal, by being the vehicle or introducer of the oxygen which burnt up and destroyed the organic matter. The spongy iron certainly effected this in a very complete way. He had tried water which was contaminated, not with two per cent. of sewage, but was simply dilute sewage, and succeeded in depriving it almost completely of organic matter by passing it slowly through the spongy iron, at any rate, to such an extent that several litres when evaporated to dryness left a perfectly white residue. Of course he took great precaution to effect the filtration very gradually. Perhaps Mr. Bischof would allow him to refer to one or two defects of his filter. One was that it did not filter sufficiently rapidly; he might perhaps say that that was an advantage, but certainly it acted very slowly. This might arise from the fact that servants were not always very careful; and if there was a ball-tap to insure a constant supply, there would not, perhaps, be so much complaint. He had also found a filter soon become choked at the top by oxidation, so that no water could pass through it. This took place very rapidly unless the water were kept constantly supplied; and, perhaps, if that were attended to, this defect would not arise.

Mr. Bischof, in reply, said he had been charged by several gentlemen with omissions, to which he must plead guilty, but could only say that if he had had an unlimited allowance of time, he would have given unlimited information, but in the short time at his disposal he had tried to say as much as could be said. Dr. Bartlett had complained that the use of the prepared sand was not sufficiently explained, but he had stated distinctly that it consisted of three layers, and dealt with the action of the pyrolusite, which he had experimentally investigated. He also wished to know whether he employed animal charcoal. It was employed, about three years ago, in spongy iron filters, for abstracting the iron in solution, which it did, but not so actively as the pyrolusite; and, moreover, although the animal charcoal was only in contact with water which had been already purified, he found that all the defects of unfiltered water were to be found in water after it passed through that medium. Dr. Bartlett had spoken of putrefaction in spongy iron, but he had endeavoured to demonstrate that the processes of putrefaction and fermentation were impossible in that medium. He also wished to know what became of the ammonia. He must very well know that you could not wash ferric oxide precipitated by ammonia free from ammonia, and ferric hydrate might retain, comparatively speaking, large quantities of ammonia in the same manner in which they found it in their analytical laboratories. He also wanted him to account for the hardness of the water. He had given one explanation or suggestion of how it might be accounted for, and with regard to the lime deposited, that was very largely retained in the iron, and, therefore, in very hard water the sand required more frequent renewal. He did not hesitate to acknowledge the significance, generally speaking, of ammonia in water, but speaking to chemists, he might refer to an article in the *Chemical News* a few weeks ago, where he pointed out a few samples of water, which, although quite free from ammonia, were decidedly impure, and to another containing a very large quantity of ammonia, which was undoubtedly a pure sample. Chemists, therefore, must accept the indication of ammonia *cum grano salis*. You could not say if it contained so much ammonia you must condemn it, and if the ammonia were produced by a chemical agency, such as took place in a spongy iron filter, it must be looked at differently. The Chairman had dealt with the question of the relative efficiency of filtering on a large or a small scale. If you had a filter in your own house, and were careful of it, you would know what you had, but if you accept the water as first delivered to you, judging by the Registrar-General's report, it was not always satisfactory; and by the use of a domestic filter you would be more sure of having a pure water supply. To Mr. Death he would only make one suggestion, namely, that the removal of organic nitrogen appeared to him of much greater importance than the removal of organic carbon, because the nitrogen pointed to animal contamination, whilst the carbon showed only vegetable impurities; for instance, algæ in water might cause a considerable amount of organic carbon, and these were found in the purest water, but organic nitrogen always pointed to the most dangerous animal contamination. Mr. Wanklyn had referred to the silicated carbon filter, and stated that the water purified through it had no organic matter whatever, but he expressly said he could not give any figures.

Mr. Wanklyn explained that the absence of figures only related to the comparative times of filtration; he had repeatedly published figures showing the degree of purification.

Mr. Bischof, said Mr. Spencer was eminently mistaken if he supposed the difference in appearance on passing the electric ray through filtered was due to the absence of magnesia and lime, because those bodies were in solution, and therefore could have nothing to do with any difference in the appearance. Whether there was any novelty in spongy iron was not a question of any interest to the meeting.

The Chairman then proposed a vote of thanks to Mr. Bischof, which was carried unnimously.

AFRICAN SECTION.

Tuesday, April 30th; J. A. Froude in the chair.

The paper read was—

THE PROGRESS OF AGRICULTURE AND STOCK FARMING IN THE COLONY OF NATAL.

By Peter M. Sutherland, M.D.,
Surveyor-General in Natal.

The territory of Natal was first occupied by the Dutch immigrant farmers, or Boers, about the year 1839. In that year six houses made their appearance upon the upland slope, where the city of Pietermaritzburg now stands.

These pioneer settlers in Natal brought with them their oxen and horses. They were for the most part Cape farmers, who had taken offence at some of the Government regulations in the old British colony, and who had gone forward from it into the wilderness to escape the constraints that were distasteful to them there. They descended from the high table land of the interior into Natal, and brought their families and worldly goods with them. They came down, each man driving his wagon, and riding his horse; and many of them with an attendance of considerable herds of cattle, which had been reared upon the pastures of the old colony. After some transient troubles, incident to their conflict with the natives, the pastoral part of the new settlement was divided into farms of 6,000 acres extent, and upon those farms the Boers erected their homesteads, and sat down.

For about sixteen years the stock farming of these uplands proved to be a profitable and thriving occupation, although conducted in the simplest possible way. The grass, which was in the richest luxuriance during the summer season of abundant rain and genial warmth, was scarce in the dry season of winter. But the original Boer turned the flank of this difficulty by selecting low situations for winter farms, as well as highland farms for the summer feeding. The cattle were driven down to the sheltered valleys, where grass was still moist and green during the dry season of deficient rain, and were then returned to the hill pastures when the young grass of the spring began to appear. These tactics were quite practicable in those early days when any man could get an additional farm of 6,000 acres by asking for it. The plan was also supported by the constant burning of the grass in the dry pastures, so that young blades might spring forth from the parched ground at the earliest possible opportunity.

In the year 1854, however, the epidemic pleuro-pneumonia appeared amongst the cattle of Natal. It was unquestionably introduced into the colony from the Transvaal. Mr. G. W. Baker, of Pietermaritzburg, in the May or June of that year, purchased in the market of the city a troop of 40 oxen which had just arrived from the Transvaal for sale. It was afterwards found that two of the troop had fallen sick on the journey down, and been shot. The troop was, however, in ignorance of this fact, sent to Mr. Baker's farm, of Slang Spruit, near the city, and mixed there with a herd of 250 head of cattle, which were feeding on the pasture. A month after this elapsed before any serious illness manifested itself. Then, however, some of the new purchase showed signs of the serious disease, and this forthwith spread with great rapidity amongst the rest of the herd. At the end of three months there remained of the 290 animals only 30 oxen, reduced almost to skin and bone. Scarcely one animal escaped the infection. Between the time of the purchase of the oxen and the breaking out of the disease, a few cows had been sold, and sent to various parts of the colony. Wherever these went the lung-sickness appeared. Since that time the disease has spread all over the colony but it has undoubtedly been from time to time re-introduced by other importations from infected districts beyond the frontier. It has been found that scarcely more than four per cent. of the cattle which were exposed to the infection escaped this disease, and very severe losses have consequently been experienced. The first severity of the sickness passed away, after having claimed its heavy tribute of victims. But the disease has appeared again and again in a somewhat milder form. The disease assumes the most deadly aspect when it occurs in seasons of great heat and moisture, and it wears its mildest aspect when it occurs in the cool months of the early spring. Farmers in Natal now look to save half the cattle that are attacked by the disease. It should also, perhaps, be remarked that the actual loss caused to the farmers by the occurrence of this disease has not been altogether so large as might, at the first glance, be conceived, on account of the very high prices commanded for catttle as their numbers decreased. Oxen in South Africa furnish transport power as well as beef, and for the purposes of transport and work they are even more indispensable than for beef, because there is nothing else that can yet take their place in performing that service. The price of oxen, on this account, pretty fairly indicates the prevalence or absence of the lung-sickness. Oxen were commonly sold in Natal before the advent of the disease for from £2 to £4 a head. The oxen quoted in a recent return for stock were from £9 to 10 guineas a head.

One still more notable and beneficent result of the unwelcome visitation has, however, been the introduction of woolled sheep into Natal. To help to make up for their losses in cattle, the immigrant farmers in Natal brought in sheep from the old colony in 1855; and it was soon found that with a judicious selection of runs, and under good management, the animals throve very well. Previously to that year mutton was a thing unknown in Natal. Within four years of that time it presented itself upon every colonist's table, and sheep's wool began to make its appearance as a regular export. In a recent return the wool-bearing sheep within the colony are set down at 336,000.

The great difficulty which has been experienced in the management of stock in Natal has unquestionably been due to the poverty, and often absolute dearth of the natural pasture during the rainless season of the winter. It is the leading characteristic of the otherwise beautiful climate of this part of South Africa that the period of cold is intimately associated with the season of deficient food. It is well known in Natal that animals must be brought into a good condition before the end of December, if they are to be fit either for road or farm work, or for slaughter, before the end of March. If the animals are not brought into a good condition by the end of the year, there is but a small chance of that result being secured in suc-

ceeding months; and, on the other hand, there is a very strong probability, indeed, that many of them will not survive the winter at all. The nutritious properties of the natural grass attain their maximum before the period of its maximum growth; and the animals consequently improve most quickly in condition if they are feeding upon the pasture at that early time when the nutritious juices are in excess of the insoluble and unnutritious tissues. Later in the season, the starch, gum, and fleshmaking constituents disappear from the plants, and their places are taken by principles which are incapable of assimilation by the animal when employed as food, and which are only fit for the manure-heaps, the flames, or slow decay in the ground. To properly utilise the grass as a winter food it should be cut, made into hay, and stacked away when its nutritious properties are in their fullest perfection. Under such circumstances the grass really loses nothing but its water. At an earlier time the gross mistake was commonly made of not using the scythe until the dry weather of winter had set in, on account of the great ease with which the so-called hay can then be loaded up, and delivered without the slightest risk of wet weather. A much better appreciation of the object which has to be ensured, is now, however, found amongst Natal farmers, and a far more satisfactory practice is, happily, being inaugurated. The importance of perseverance in this improved method of procedure cannot possibly be over-estimated. The entire future of Natal farming hangs, indeed, upon this pivot. The summer is a season of over abundant luxuriance and growth. The winter is a season of deficiency and starvation. The problem to be solved is therefore how best to preserve the excess of the early luxuriance for the time of deficiency and dearth. The storing of properly made nutritious hay, and the cultivation of green crops, are the efficient removal of the difficulty which was only partially and imperfectly evaded by the winter farms of the early Boers.

Some experiments of very great interest have recently been made in Natal, leading to the preservation of grass in the moist state by the process which is termed "ensilage." A pit is excavated in the ground in some dry situation, and then filled with recently cut grass, which is packed closely down, and carefully covered up with a substantial layer of soil to exclude the air. The grass stored in this way is apparently unchanged in its nutritive properties, and quite available for feeding purposes when the pits are opened out months afterwards. Cattle consume it with avidity, and seem to thrive well upon it.

The Caucasian Prickly Comfrey (*Symphytum asperrimum*) has recently been introduced into the colony by the Botanic Society of Pietermaritzburg, and Mr. Joseph Henderson, and it is greatly hoped that it will prove a valuable fodder in Natal. The plant, which is allied to the Borage, is a native of the mountainous regions of Circassia, and has been long used as a forage both in Russia and Circassia. Its original home is at a height of 4,000 feet above the sea; but it thrives well in a great diversity of climates, and bears hot and dry seasons with impunity, on account of the depth to which its strong root penetrates into the ground. There are two varieties of the plant, one with a hollow, and the other with a solid stem. The latter proves itself a most excellent food for all kind of stock, and especially increases the quantity, and improves the quality of the milk of cows. It grows with marvellous rapidity and luxuriance. Land which yields eight tons of grass per acre, gives from 60 to 150 tons of comfrey. The plant is four or five feet high when near flowering, and the leaves attain a length of three feet. The flowers abound in honey. The solid stem is like a succulent root, and the plant is easily propagated by cuttings from this stem, containing a couple of eyes upon each. When once well rooted it will go on producing from 15 to 20 years without renewal. The fodder may be cut six or even eight times a year; and if the leaves are stacked green, or partially dried, with a little salt between the layers, keeps well through the winter. The plant does not seem to suffer at all from slight frost. All kinds of live stock feed upon it eagerly, and fatten with its use.

But the farmer in Natal is, fortunately, not entirely dependent upon hay for the winter food of his stock. The mealie crop, or Indian corn, under proper management, is a never-failing resource. The Zea maize grows in nearly all parts of the colony with the utmost luxuriance. Two and three cobs are occasionally produced from a single seed, aud cobs are not unfrequently found which are 12 in. long and 4 lbs. in weight, and which bear as many as 800 grains. It is now pretty generally admitted that the maize plant is, in reality, a native of the South of Europe, Africa, and Asia, and that it was known in all those countries before the discovery of America by Europeans. The importance of this splendid cereal to the colony is very well expressed in the salient fact that, at the present time, some 15,000 acres of land are occupied by its cultivation by white settlers, and close upon 110,000 acres of land by the black population. The average annual produce from this land is about 250,000 bushels for the white settlers, and 1,250,000 for the blacks. With a good selection of soil, and skilful cultivation, the average yield is very nearly, indeed, up to that which is attained in Illinois, namely, 34 bushels per acre. But there are unquestionable instances in which 90 bushels per acre have been reaped in Natal. Notwithstanding the ready growth, and the large production, there is, however, still a large margin for the increased cultivation of this serviceable grain, as is very well indicated in the extraordinary extremes of price which it realises in the markets of the chief towns, during even a single year. It is still by no means an uncommon event for this prime necessary of life to treble its price in the brief period of scarcity, which immediately precedes the reaping of the new crops.

It is a matter of some practical moment to decide upon the best method of storing this somewhat delicate and perishable grain. It is attacked both by the weevil and the corn moth (*Tinea granella*). The natives enclose it in subteranean stores, or pits, which are carefully covered over with earth. But when this method is adopted, the grain is so seriously damaged by damp, and the exclusion of air, that it becomes unfit to be employed as human food, and is often an object of repulsion and disgust even to horses. What is required is some means of excluding the

access of insects, and still allowing a moderate and judiciously restricted circulation of air. Up to the present time no efficient means have been devised for preserving any excess of the maize-crop well over into the successive season of growth.

When maize is used as winter food for live stock, it should invariably be soaked for six hours before it is given to the animals. When this is not done it must be employed in the condition of meal, and it is then not enough that it should be coarsely crushed. It has been found that 3 lbs. of fine meal furnish more actual nourishment to a ruminant animal than 6 lbs. of coarsely crushed, or 9 lbs. of the uncrushed, grain. When the grain is given whole, a very large proportion of its nutritive part part passes away undigested, and therefore unused. The fattening power of maize is a well determined fact. Even in European countries it is to some extent employed as food for stock. The patent food of the English slaughter markets is in the main, oil-cake mingled with the finely ground meal of maize.

The death-rate of sheep during the lambing season in Natal at the present time bears comparison with that of other countries, but it is confidently anticipated that even this rate will be considerably reduced when an abundant supply of artificially grown succulent food is provided for this season of scarcity. Deficiency of nourishment invariably leads to weakness and sickness. But it is worthy of remark, that in the South African colonies the wool itself is affected by the same influence. In the South African wool there is commonly a weak place in the fibre—a break in the staple—which materially lowers its value in the markets. This weak place in the fibre is mainly due to deficiency of food at the time when that part of the fleece is prepared. The wool, in fact, needs to be well fed throughout the year, as well as the carcass. This remark applies with equal force to the wool of all the South African districts. A considerable addition will be made to the value of the clip when a better system of winter feeding is adopted.

In a recent return (for the beginning of the year 1877) the annual production of sheep's wool in Natal is set down at 892,000 lbs. But the export of wool from Natal for the same year was 8,500,000 lbs. This simply means, that of the 8,500,000 lbs. sent from Natal over the sea, something like 7,600,000 lbs. was the produce of sheep fed in the interior lands beyond the frontier, and brought down to Natal for shipment.

Horses have always been reared with the cattle throughout the settled parts of South Africa, and thrive well upon the hills and high pastures; but they are prone to serious disease on the low lying and hot portions of the sea coast. They were brought into Natal in considerable numbers when the Dutch farmers first came down into the district. They played an important part in the first memorable struggles with the natives. The Boers always fought on horseback.

Since those early days the horse has not only maintained its position in Natal, but has been materially improved in its breed by the care which has been given to it by English settlers. Several valuable horses have been imported into the colony, and there are some deservedly esteemed horse-runs amongst the hill districts. For many years the horse was used only with the saddle. But it is now gradually taking its proper place both for road-work and farm-work. Both transport of the mails and passenger traffic are, with each succeeding year, being more and more transferred to the horse. Increased and more generally adopted production of artificial food will do more than any circumstance to quicken this desirable change. It is, however, a significant fact that in the lists of marked prices a distinction is now made between riding horses and draught horses. In the Natal "Almanac and Register" for 1878, which has quite recently been printed, saddle horses are quoted as selling for from £10 to £21; and draught horses from £12 to £25. The average price for the saddle horse throughout the colony is set down at £26 11s., and for the draught horse at a trifle less than £19 10s. Ten years ago the number of horses in Natal was estimated at nearly 17,000. Last year the number returned was 15,000; and there were about half as many again in the hands of the natives. The largely increased demand, no doubt, has much to do with the numbers not showing an increase. The expenditure is heavy in comparison with the increase.

The horse sickness of Natal, which occasionally assumes a serious and fatal form, especially in low lying districts, and on the coast, is now generally looked upon as an indigenous, or native, and not an imported disease. The veterinary surgeon of the colony holds that it is not due to miasma, but to some injurious influence introduced either with the food or drink, and made more energetically mischievous perhaps by some as yet imperfectly ascertained conditions and vicissitudes of the atmosphere. The disease seems to be very largely within the remedial power of the supply of good food through all parts of the year, and judicious shelter from sun, rain, and atmospheric chill and moisture. It is very confidently expected that an improved system of agriculture will ultimately prove the best antagonist to this troublesome and destructive visitant. In his official report, the veterinary surgeon states that he had only encountered five instances of this disease amongst horses during the previous year.

Wheat is grown on most upland farms, at least, for home consumption. But the annual import of wheat and rice for Natal at the present time reaches the large value of £50,000 sterling. Yet both grains can be produced in the colony, in any quantity, under good management. The wheat producing powers of some of the most fertile districts of the Transvaal, which lie only just beyond the upland frontier of Natal, is matter of familiar notoriety.

The chief difficulty hitherto with wheat in Natal has been the somewhat unfavourable circumstance of the wetness of the natural season of harvest. The summer rains are falling in constantly recurring abundance, when the wheat comes naturally into ear, and this makes it very difficult to secure the crop in good condition. Mildew is an evil of very general occurrence. But, on the other hand, the season of winter, with its mean temperature of about 64° of Fahr., and with its prevalence of almost unfailing sunshine, enables corn crops of the finest character to be secured before the rains commence, if a good system of irrigation is practised. This, no

doubt, is the proper solution of the difficulty. The corn crops in Natal should be winter grown. The rain itself, which is so bountifully abundant from October to March, should be economically husbanded and preserved. There is enough of it, and very much more than enough, to keep the warm earth teeming with crops through the dry season of sunshine, if it is skilfully managed, and there is scarcely a spot possessing productive soil, where it may not be readily collected and stored. The mean annual rainfall for the midlands and uplands of Natal is close upon 30 inches, or something more than half as much again as that of the agricultural districts of England.

In the adjoining colony of the Cape of Good Hope, this bearing of the case has at length been recognised as one of so much practical importance, that an officer has been appointed to inquire into the practicability of establishing a well considered and carefully planned system of irrigation in promising and suitable tracts. An "Irrigation Act" has also been passed, which allows irrigation boards and irrigation associations to be formed, through which land owners and tenant farmers may combine to construct reservoirs, conduits, and canals, under loans, at low rates of interest, to be gradually repaid in periods of 25 years. In this arrangement the repayment of the loan assumes very much the character of an annual rent for the use of water. This is an example which is well worthy of imitation.

In the early practice of farming in Natal, the systematic use of manure was a thing entirely unknown. This, of course, would naturally follow from the plan of feeding the stock broadcast over the land, and making no provision at all of winter food. Exhausted fields that had been cropped for a brief period were then given up to the weeds. Even when the planting of sugar was fairly established as a remunerative enterprise upon the coast, this rude and wasteful practice was pursued, notwithstanding the rapidly increasing price of the land, and the difficulty and high cost of transport, in the districts where that valuable product could be grown and manufactured. The neglect of the more rational plan of cultivation in this instance proved actually ruinous in many cases, on account of the great distance from which the cane had often to be carried to the mill, in a hilly country, where animals only were to be relied upon for traction. In the production of sugar, one ton of the finished product implies, upon an average, the transport of about 20 tons of cane. In circumstances such as have to be encountered in Natal, it is quite indispensable, therefore, for the economical and profitable production of sugar, that distance of transport shall be reduced within the smallest attainable limit, and that the fields which are contiguous to the factory shall be maintained in the highest possible state of fertility; but to the up-country farmer who deals with root crops and grain crops the matter is scarcely of less moment, because year by year his fences must be extended, at a very large cost, when he widens the area under cultivation. When land is unproductive, in consequence of want of manure, the first cost of fencing is also unproductive. On this account, in up-country farms, a commodious weather-proof shed, for the protection of cattle at night, should always be provided, and hay be supplied in quantity sufficient for the absorption and retention of the animal excreta. Comfortable space should be left in the shed for each animal, and there should be an accumulation of the manure to the depth of, at least, 6 ft. in the course of a year. At the beginning of the spring the whole should be turned over from top to bottom, just as land is when subsoiled, or trenched. This promotes fermentation, which effectually reduces fibrous grasses to a pulp, and saturates them with ammoniacal substances in a state which is as convenient as it is beneficial for application to the soil. This is a somewhat costly process, but it is quite indispensable to successful farming. It has been ascertained that 16 head of cattle, or horses, well pastured during the day, and housed with bedding of hay or grass at night, yield not less than one ton of excellent manure. Green crops of various kinds may also be advantageously ploughed into the ground, to act as enriching manure. Plants with large leaves are preferable for this purpose, because it is the carbon which is drawn by the leaf out of the air that is principally turned to account. The carbonaceous parts of the plant are gradually converted into vegetable mould.

Several attempts have been recently been made to introduce the cultivation of the hemp plant into Natal, but without success. In two instances in which the plant germinated it did not produce seed. It so happens, however, that there is a native variety of this valuable plant, or possibly of the *Cannabis indica*, which is a near ally of the European hemp, which grows everywhere with the most unstinted luxuriance, and which yields an excellent fibre. It is known by the native names of "Insangu" and "Dacha," and is very generally used by the natives for the manufacture of a coarse cordage. The dried stem is also smoked for its narcotic effects. The plant is, indeed, the same that furnishes the Arabs of the northern part of the continent with "Hasheesh." It is most generally found as a kind of naturalised weed, growing round the margin of cultivated lands and about native homesteads where the soil has been fertilised by the occasional presence of live stock. But it also occurs unquestionably as an indigenous plant on alluvial lands subject to periodic inundation. It grows from three to ten feet high, and has been hitherto perpetuated by the merely accidental escape of some few seeds from the insatiable voracity of birds and rodents. In the neighbourhood of domestic fowls, not a single seed escapes. The plant is on this account generally met with only in isolated specimens scattered very widely apart. The seed is small, round, and mottled, and runs about 50,000 to the pound. It thrives well upon land worn out from over cropping with maize, and over-run with weeds. With due moisture and warmth the plant appears above the ground a week after the sowing of the seed, and almost immediately outgrows all weeds. It attains commonly a height of ten feet in four months, and is ready for cutting at the end of the fifth. It cannot be pulled on account of the vigorous development of its roots. The seed also has a marvellous retention of vitality. It will remain dormant, but unharmed, in the ground in the absence of rain for months, under circumstances that would effectually destroy all germinating power in maize in a single week, The stem, when

cut, may be stacked until it is convenient to remove it for manufacture. About sixteen tons of the green plant, or four tons of the dried stems, are easily grown per acre. The yield of marketable fibre from this quantity amounts to half a ton, worth £20. Samples transmitted to competent hemp brokers in London have been pronounced as of equal value with the best Italian hemp. It is of great importance, in reference to this crop, that produce may be stored away for unlimited periods for the opportunity of a good market. It is probable that alternate cropping of land with hemp and maize would be found to be a very excellent process. At a recent time about forty bushels of the seeds of the wild plant had been collected from various localities, and arrangements were in progress for sowing these upon fifty acres of carefully prepared land, from which a harvest was looked for of not less than 1,000 bushels of seed, and one hundred bales of fibre.

In a recent report of the Agricultural Society in Natal, attention was drawn to the paramount necessity for some well organised and largely extended scheme for planting timber. The consumption of wood, as fuel, in the City alone, was, at that time, estimated as costing £3,000 a year, the supply being already sought in many instances at a distance of 25 miles. It has been well ascertained that the area of ground planted with bluegum, or black wattle trees, would yield 600 cubic feet of wood, worth £130 in ten years, giving an average production of £13 per annum per acre. The progress of the railway, which is now in process of construction from the port to the capital, is looked upon with some anxiety from this point of view, as every mile will cost £100 a year for fuel, and will materially reduce the already too limited supply unless some bold measure of planting is at once entered upon. The report points out that the land between Durban and Pietermaritzburg, through which the railway has to pass, would easily be made to return a never failing revenue of £7,000 a year by the production of fuel for the locomotive.

In connection with this branch of industry, attention has been appropriately drawn, in the volume of the "Natal Almanac and Register" for the present year, to an ingenious plan of planting devised by Mr. James Walker, a well-known resident in the colony. He constructs coarse earthen sun-dried pots, out of tempered clay. The seeds are planted in these pots, and the growing plants are then kept in a nursery until ready for planting out. They can at that time be transported to any distance, and having been deposited in a prepared hollow or trench, the sides of the pots can be broken into small pieces without disturbing the rootlets contained therein, and the ground is then covered in, and made good to the general level of the surface. The natives say, in reference to this method of planting, that the plants themselves "never know that they have been removed."

In concluding the reading of this paper, Dr. Mann said:—

The white-skinned population of Natal has but quite recently reached the number of 21,000. At the period of the last estimated return the population of the colony was reckoned at 21,500 whites, 10,300 Indian coolies, 272,000 Kafirs, and 2,500 drawn from other sources or nationalities, making up a sum total slightly in excess of 306,000. Of these the industrial forces of the colony would probably be principally centred in the 30,000 whites and Indian coolies. Some considerable amount of work is contributed by Kafirs, but in so fitful and uncertain a form that it is difficult to make any fair or reliable estimate of it in figures. In 1867 the white population amounted to 16,600. The increase of white people has therefore been only 5,000 in ten years. This gives a fair expression of the rate at which the population within the colony increases. The industrial activity of the place can, however, in no way be adequately estimated by the mere growth of its population. Thus, during the ten years in which the population has increased from 16,000 to 21,000, the value of the exports of Natal have increased from £210,000 to £835,000. The commercial history of Natal as a British dependency may be held to date from 1846, the third year after its formal annexation by the British Government. The shipping employed by the colony in that year was a little more than 3,000 tons, and the exports were of the value of £17,000. The value reached £100,000 in 1858, £220,000 in 1864, £363,000 in 1869, £562,000 in 1871, £651,000 in 1873, £770,000 in 1874, and £835,643 in 1875.

In speaking of these values, however, it is necessary to remark that the whole is not by any means due to the industries of the colony. A very large portion of it concerns certain products of the pasture and the chase which come down into Natal from the interior lands for shipment. Thus it has been stated in Dr. Sutherland's paper that the value of sheeps' wool shipped at the port of Natal in 1875 was £389,000; but of this certainly not more than an eighth part, or in round numbers £50,000, could have been the produce of Natal. A further reduction from the value of exports to a considerable amount would have to be made for such articles as gold dust, ivory, skins, and tools that are produced beyond the inland frontier, and that are brought down into Natal for shipment. In all probability not less than one half of the value returned for exports from Natal should be ascribed to merchandise brought in from beyond the frontier. But even with this allowance there still remains the not unsatisfactory result of something more than a four-fold increase within the ten years, during which the increase in the number of the producing ranks of the population could scarcely have exceeded 30 per cent.

In his two brilliant volumes, describing his recent visit to South Africa, Mr. Trollope sketches very truly and happily many of the social peculiarities of the place. In speaking of the capital of Natal, he says, "I liked Pietermaritzburg very much, perhaps the best of all South African towns. But whenever I would express such an opinion to a Pietermaritzburger he would never quite agree with me. It is difficult to get a colonist to assent to any opinion as to his own colony. If you find fault, he is injured and almost insulted. The traveller soon learns that he had better abstain from all spoken criticism, even when that often repeated, that dreadful question is put to him, which I was called upon to answer sometimes four times a day, 'Well, what do you think of——'—let us say for the moment, 'South

Africa?' But even praise is not accepted without contradiction, and the peculiar hardships of a colonist's life are insisted upon almost with indignation when colonial blessings are spoken of with admiration. The Government at home is doing everything that is cruel, and the Government in the colony is doing everything that is foolish. With whatever interest the gentleman himself is concerned, that peculiar interest is peculiarly ill-managed by the existing powers. But for some famous maddening law he himself could make his own fortune, and almost that of the colony. In Pietermaritzburg everybody seemed to me very comfortable, but everybody was ill-used. There was no labour, though the streets were full of Zulus, who would do anything for a shilling, and half anything for sixpence. There was no emigration from England provided for by the country. There were not half soldiers enough in Natal, though Natal has luckily had no real use for soldiers since the Dutch went away. But perhaps the most popular source of complaint was that everything was so dear that nobody could afford to live. Nevertheless I did not hear that any great number of the inhabitants of the town were encumbered by debt, and everybody seemed to live comfortably enough."

This view, so cleverly and amusingly expressed by the accomplished and shrewd observer, is amply confirmed when figures are again drawn into the argument. It appears that the value of the articles of home manufacture and of luxury imported in the last year for which there is yet a complete return, namely, for 1876, and which were, of course, almost entirely supplies for the consumption of the upper 21,000 of the population, amounted to no less a sum than £1,022,000. That is to say, besides the prime necessaries of life which were extracted from the genial climate and the productive soil for their use, the Natal colonists managed in some way to have more than a million of money to spend within the year upon goods that had to be brought to them seven thousand miles over the sea. The Natal bills for beer, wine, and ardent spirits, irrespective of the peach brandy and rum produced in the colony, amounted in 1876 to £62,000; for imported tobacco, £9,000; the ladies' account for haberdashery and millinery, £74,000; manufactured woollen and cotton goods, £227,000; hardware and machinery, £154,000; saddlery and leather goods, £79,000.

The peculiarity which is so amusingly and delicately referred to by Mr. Trollope in his "South Africa" is, in a large measure, due to the two sides of the experience which every colonist has to meet, let his lot be cast where it may. It so happens that, since the misconduct of Adam, Gardens of Eden have no longer been open to occupation upon the earth. In every land the account that has to be rendered of human life is a balance between advantages and drawbacks, and it is only in the nature of things that disappointments and failures should make a stronger impression upon the mind than the opposite side of the bargain. The advantages in Natal that have to be placed upon one side of the account are easily acquired land, cheap native labour, a most genial climate, immense diversity and choice of territorial positions, and independent and unconstrained habits of life. The conditions that tell most on the opposite side are the rudeness, uncertainty, and unreliability of the labour, the high cost of skilled work and constructive material, the deficiency of household service, the prevalence of indigenous diseases amongst the live stock, the slowness and costliness of transport, and the insufficiency of markets for produce. Many of those who conversed with Mr. Trollope would, in all probability, have added on this side of the account the high rate of interest for borrowed capital.

The remarkable diversity of the characters of the various colonial dependencies of the empire so widely scattered over the globe, is, virtually, an almost incalculable gain. It practically acts as an enlargement of their area. The colonies of an active and enterprising race are properly but extensions of the parent soil, and expansions of industrial and productive opportunity.

This view of the matter has, however, been so admirably expressed by an authority who has pretty well made the subject his own by the careful thought that he has given it, that I cannot refrain, even in the presence of the gentleman who occupies the chair, from drawing attention to one eloquent passage which appears in a well-known book, and from commending its arguments to the consideration of the meeting.*

The passage runs, "Is it, however, absolutely necessary that the whole weight of the commonwealth should be thrown upon trade? Is there no second or steadier basis to be found anywhere? I cannot myself contemplate the enclosure of the English nation within these islands with an increasing manufacturing population, and not feel a misgiving that we shall fail in securing even those material objects to which our other prospects are to be sacrificed. We shall not be contented to sink into a second place. A growth of population we must have to keep pace with the nations around us; and unless we can breed up part of our people in occupations more healthy for mind and body than can be found in the coal pit or workshop, unless we preserve in sufficient numbers the purity and vigour of our race; if we trust entirely to the expansion of our towns; we are sacrificing to immediate and mean temptations the stability of the empire which we have inherited.

"If we are to take hostages of the future we require an agricultural population independent of and beside the towns. We have no longer land enough in England commensurate with our present dimensions, and the land that we have lies under conditions which only a revolution can divide again among small cultivators. A convulsion which would break up the great estates would destroy the entire constitution. It is not the law of the land, it is not custom, it is not the pride of family which causes the agglomeration. It is an economic law which legislation can no more alter than it can alter the law of gravity.

"Other nations much more powerful than ourselves, are growing in strength and numbers, and we too must grow if we intend to remain on a level with them. Here, at home, we have no room to grow except by the expansion of towns, which are already overgrown, which we know not certainly that we can expand. If we succeed it can only be

* See "The Colonies and England's War." Short Studies on Great Subjects. Series 2. By J. A. Froude.

under conditions unfavourable, and probably destructive, to the physical constitution of our people, and our greatness will be held by a tenure, which, in the nature of things, must become more and more precarious.

"But easily within our reach there are our Eastern and Western colonies containing all, and more than all, that we require. We want land on which to plant English families where they may thrive and multiply without ceasing to be Englishmen. The colonies contain virgin soil sufficient to employ and feed five times as many people as are now crowded into Great Britain and Ireland. Nothing is needed but arms to cultivate it, while here, among ourselves, are millions of able-bodied men unwillingly idle, clamouring for work, with their families starving upon their hands. What more simple than to bring the men and the land together? . . . The colonies in reality set more value than we do ourselves on the prosperity of the empire. Their ambition is to draw closer to us, to be absorbed into a united empire. Every able-bodied workman who lands on their shores is so much added to their wealth as well as ours. Each husband and wife as they establish themselves become as a fresh root for the old tree, struck into a new soil. . . . . If England were to spend one quarter the sums which were sunk in the morasses at Balaclava in sending out and establishing two millions of our people in our colonies, it would contribute more to the essential strength of the country than all the wars in which we have been entangled from Agincourt to Waterloo. No further subsidies would be needed to feed the stream; once settled they would multiply and draw their relations after them, and at great stations round the globe there would grow up, under conditions the most favourable which the human constitution can desire, fresh nations of Englishmen, so strongly placed, and with numbers growing in geometrical proportion, they would be at once feeding places of our population, and self-supporting imperial garrisons themselves unconquerable. With our roots thus struck so deeply into the earth, it is hard to see what dangers, internal or external, we should have cause to fear, or what impediments could then check the indefinite and magnificent expansion of the English empire."

It is from the point of view that is suggested by these thoughtful and eloquent words that Dr. Sutherland's contribution acquires its chief value. The force of his argument lies in the advocacy of an improved system of farming in Natal by which winter food shall be provided for the live stock, and winter crops be grown through the storage of the abundant summer rain, and through the adoption of an organised and methodically controlled system of irrigation in the dry and so-called season of winter; which in Natal, however, is not really winter at all, but a time of general and almost unfailing sunshine and warmth. During my own ten years' series of observations in Pietermaritzburg, which is 2,095 feet above the sea, there were only ten occasions, amounting on the average to one night per year, on which frost occurred. There were upon the average only 22 nights in the year on which the temperature fell so low as 40°, and 11 days in the year in which it did not rise to 60°. The mean temperature of the six coldest months of the year, or what may be termed the mean winter temperature, was 59·9°; and the average highest temperature of the day for those winter months was 82·2°; and the average lowest of the night 39·4. During the same period of ten years the average annual rainfall was 30 inches, and of this 25 inches fell during the six summer months, and 5 inches during the six dry months in which the help of irrigation is required. On one occasion during the ten years there was a continuous period of 107 days without rain, and on 20 occasions there were rainless periods extending between 20 and 68 days. These figures, drawn from actual and close observation, substantially and forcibly support that portion of Dr. Sutherland's paper which advocates a systematised plan of irrigation.

The principal articles of production to which the industrial energies of the people of Natal have been directed up to this time are wheat, Indian corn, oats, forage, sugar, coffee, arrowroot, tobacco, dairy produce, wool, hides, oxen, sheep, and goats. It will be perceived that there is an ample field in this list for successful work if the improved methods advocated by Dr. Sutherland are applied. All who are acquainted with the colony, indeed, are aware that under such management, and with the final substitution of skilful cultivation for the rude pastoral farming of the primitive pioneers, the colony is capable of providing for the comfort and support of a population that may be numbered by millions instead of thousands, and of so playing a by no means unimportant part in that process of the colonial expansion of the imperial prosperity and strength which has been so ably advocated in many of his writings by our chairman. The singularly large increase of the native tribes in Natal, and the social state of that portion of the community, is a matter for serious consideration in connection with this view of the subject; but it is obviously one that is too large to be touched upon at the end of a paper, and that must therefore be reserved for future examination. But in the meantime it may perhaps be not deemed unworthy of notice that upon the occasion of the last return there were 2,677 ploughs on the record marked as belonging to natives. The resident magistrate of the recently annexed and comparatively outlying county of Alfred, not long since known under the not very promising designation of No Man's Land, speaks with some self-congratulation of the growing habit of purchasing ploughs by his people. The resident magistrate of Weenen County also speaks for the first time of 37 acres of wheat grown by the natives in his district. Mr. Trollope, on the occasion of his recent visit to South Africa, was surprised at the amount of work which is already performed by the naturally indolent natives, and has some passages in his volumes on "South Africa" bearing upon the civilising influence of the diamond mines, which are well deserving of thoughtful attention.*

DISCUSSION.

Mr. Sanderson said he had had much pleasure in listening to the paper. Dr. Sutherland was a very old colonist, a man who knew every inch of Natal, a hard-

* See "South Africa," by Anthony Trollope. 2 vols. Chapman and Hall.

working, industrious public servant, and one who was well capable of turning to account the information which no man was better calculated than himself to amass. With reference to the statistics which had been quoted from the Blue-book, he wished to give a word of caution against trusting too implicitly to the figures given in the Blue-books, for he was sorry to say they were not collected with the care which ought to characterise figures, in order that any safe conclusions could be drawn from them. In reference to the wool, for instance, Dr. Mann had stated that a large proportion was the produce of the interior, and only passed through Natal; that was perfectly true, but the converse also held good with the imports, the great proportion of drink set down to the credit or discredit of Natal also went inland. Dr. Mann had quoted some remarks from Mr. Trollope as to the abundance of labour, and it was quite true that there were plenty of natives swarming in the streets, and if you wanted an errand done, you could get a native to do it for 6d. or 1s. But it was also quite true that 6d. or 1s. was more than the work was worth, and no native would do the smallest service—he would not even hold your horse for a couple of minutes at a shop-door—without exacting at least 3d., where an English street boy would be glad to earn a halfpenny. The same thing was true on the larger scale; native labour was, to a great extent, expensive labour. There was great truth in Dr. Mann's remark with regard to the improvement which had taken place amongst the natives. They were unquestionably attaining a considerable amount of civilisation; ploughs were increasing amongst them, and, considering the way in which they had been segregated from the white population, and their native habits encouraged ever since the colony was founded, the wonder rather was that they had acquired so much civilisation as they had. Some people were inclined to be too impatient for speedy results, and expected the habits of natives of savage countries to be changed in a few years. He had often been tempted to remind such people how long it took for England and Englishmen to become what they are, and to ask them to look around, and see if there were not still savages to be found on English and Irish soil. The amount of sugar produced in the colony was hardly alluded to by Dr. Sutherland, but, though he was not prepared to give the figures, he must say that it was very considerable. That which came to England was a mere trifle. A considerable quantity went to the Cape, and the whole of the interior States, the Free State, and the Transvaal, derived their supply almost exclusively from Natal. None of this appeared in the Blue-books, in fact you might read from the first page to the last and find nothing to indicate the amount of sugar that went over the berg, as it was called, into the Free State and the Transvaal. The amount of coffee produced in Natal had fallen off very considerably; certain drawbacks led people to abandon its cultivation and take to sugar instead, but he was glad to say it was once more coming into favour. Tea was also now attracting considerable attention, and an association of planters in one division of Victoria County had, with the aid of the Agricultural Society of Natal, imported a considerable quantity of seed and young plants from India. He was rather surprised to hear from Dr. Mann that the number of days on which frost occurred were only about one per annum, though he had no doubt the figures were accurate, because on the coast frost was one of the things which the sugar planters had to contend with. The valleys on the coast, which in the first instance were chiefly cultivated, were often visited by frost, and even during last season a good deal of damage was done in that way. In the town of Burden itself, where he had been resident for 28 years, frost was frequently observed—not at all severe, but just sufficient to freeze water left out of doors in a saucer. The climate of Natal was very healthy, and he should have liked to have heard a little more on that point from Dr. Mann. There were men now living in Natal—he might refer in particular to a fellow-passenger of his nearly 29 years ago, whom he never expected would reach the land, who was living, and in very fair health to this day. For consumptive patients the climate was most excellent. He could not conclude without saying that he entirely agreed with the remarks quoted from the Chairman with reference to the emigration. There was a very large field for emigration in Natal, small as it was, but emigration must be conducted on wise principles. It would not do to send Tom, Dick, and Harry to the colony. The men must be carefully selected, and prepared to encounter difficulties, undergo privations, and to do without many things which they had been accustomed to regard as necessaries. But if they were prepared for this, they would find a magnificent climate, and a field for making, if not a fortune, at least, a very good living.

The Chairman said he must beg to express for himself and all present their thanks to Dr. Mann for the extremely interesting paper he had read for Dr. Sutherland, and also for the extremely interesting remarks he had added. They were also indebted to Mr. Sanderson for the fresh information he had given them. In listening to Dr. Sutherland's paper, it brought Dr. Sutherland back to him, and he remembered many things he had said; amongst them, one very striking fact was this, that according to his estimate, the value of the grass which was annually burned off as useless amounted in the aggregate to the food of twelve million human beings. What he had seen there certainly seemed to indicate a soil of the most extraordinary fertility. Very likely Mr. Sanderson might have seen the experiment tried by Judge Phillips at Maritzburg a few years ago. He enclosed an open piece of country, about three miles outside the town, where a stream of water fell off the hills, as bare originally as a piece of Scotch moor. He took him to see it some six years afterwards, and as they came up to the place it looked as if they were coming to a great wood. Round the 45 acres he had enclosed was growing a dense belt of forest 50 ft. high at least, consisting of *Eucalyptus*, or blue gum, and an endless variety of pines, which in those six years had shot up from the seed to 50 or 60 feet high. That would show the rapidity of growth of all sorts of timber. Inside that they came to seven acres of coffee plants, which were in full bearing, and having passed those they came to groves of orange trees, lemons, and citrons; then again there were whole orchards of apples, pears, and figs, all produced from seed in six years, extensive pineries, vegetable gardens, roses, and every sort of beautiful flowering tree and shrub.

Mr. Sanderson said he knew the place very well by repute, but he had not visited it.

The Chairman said he could not but think on seeing this, what it was to have such a country as that, all ready under favourable conditions of irrigation to produce so much, and then he thought of the vast crowded population at home, and what an excellent thing it would be if they could only get in any way the people and the land together. No doubt what Mr. Sanderson said about caution in emigration was a thing to be attended to. He had always thought that Miss Rye's plan was one which might advantageously be adopted for our colonies. She was a benevolent lady who annually carried off many hundreds of friendless children to Canada, and the Canadian farmers and tradesmen were very glad to take these children, under conditions something similar to apprenticeship, and bring them in their own houses to all kinds of useful work. Surely something of that kind might be tried with great benefit to our colonies. He had spoken to many people in South Africa on the subject, and only met with one opinion, but he was sorry to say he thought England was culpably negligent in the matter. The Americans were a good deal sharper than we were. Till recently they had secured for themselves nearly 90 per cent. of the emigration from

these islands. As an American once said to him, all sorts of people came to them from all parts of the world, Germans, Norwegians, Irish, and Scotch, "but of all things give us Englishmen, they are the best of all colonists." They knew what they were doing, and had agents in England who looked out all the likeliest and best men; they bribed them with high wages, and promised to settle them, and they did settle them. A man would engage twenty or thirty men to go out to do some job, and when it was finished they contrived to settle them on the land and make Americans of them. In that way they were securing the most precious part of our superflous flesh and bone, which he thought a wise administration would endeavour to secure for our own colonies. He had only one more remark to make with reference to the extreme healthiness of the climate, and how well it suited our northern Teutonic blood. The Dutch had been there 150 years; in his own country a Dutchman was rather short and thick, a healthy vigorous man, but certainly not remarkable for his extreme size. But in South Africa they were a nation of giants, and over six feet high. He had seen families of a father and six or seven sons, not one under six feet. Of all our colonies, as far as he could see, South Africa was the one which suited our temperament the best; you would see no such men in America as you found there. Looking at them it seemed to him that there was the place where a very vigorous and powerful branch of the old English stock would take root and flourish.

The vote of thanks having been passed,

Dr. Mann said he had to add a few words in explanation of some remarks which had fallen from Mr. Sanderson. The temperature, as he had stated it, was perfectly correct, and the reason of the apparent discrepancy lay in a nutshell. His records were those of the air temperature, eight feet from the ground; and nine-tenths, or even more than that, of the frosts which occurred in Natal were what meteorologists called ground frosts, being due to the chill produced on the surface of the grass under a clear sky by radiation from the ground. If time permitted he could go into figures, and show how rare it was for a true air temperature frost to occur. Even in England frosts often occurred in the same way, as had been the case during the last few weeks, though self-recording instruments had not indicated a temperature within two degrees of frost. All his own observations were made on standard instruments, carefully verified at Kew. With regard to sugar, that question had been before the Section again and again, and he hoped it would once more be brought forward next Session; but the reason Dr. Sutherland had not gone into it was, probably, that his main experience was in the up country, to which his commuuication was primarily directed. It was undoubtedly true that there was a large production of sugar beyond 17,000 tons, which was the amount of exports stated. What Mr. Sanderson had said about the Blue-books was also true, but we unfortunate people in England could only use the materials that came to our hands. Mr. Sanderson was not aware, probably, of the enormous amount of fruitless labour he had expended in trying to get trustworthy figures for Natal, but many of his friends were, and he was so much interested in the colony that he was still in hopes of getting more and more interesting information about it to lay before the English public. The only further remark he need make was as to the healthiness of the place. That had been so largely treated by himself, in that room and other places, that it would have been almost a work of supererogation to speak of it to-night, but there was no doubt of the fact that it was one of the most healthy places amongst our colonies, if one or two precautions were taken. A few years ago he printed a most elaborately digested statement of the facts, not only from his own knowledge, but from information derived from all his medical friends in the colony. Dr. Sutherland's paper, as he understood, was directed to three principal and very important points:—1. The use of manure, more skilfully applied; 2. The production of artificial crops, which would enable a good and efficient system of feeding in winter to be followed; and 3, above all, a well organised system of irrigation, which would allow the valuable, warm, dry season of winter to be turned to account for the growth of such crops as could not be reared in the wet season of summer. Lastly, he had only to ask the meeting to return thanks to the Chairman, who had so kindly come to preside on that occasion, and who he hoped, would favour them with his presence on future occasions.

The Chairman said it had been very agreeable to him to continue in this indirect way the connection he formed with South Africa some years ago. He had formed so many friendships there that the country would always retain a first place in his sympathies, and he certainly hoped to be present at many future meetings of the Section.

NINETEENTH ORDINARY MEETING.

Wednesday, May 1st, 1878; Benjamin W. Richardson, M.D., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Banks, Edwin H., Highmoor-house, Wigton.
Gover, Dr. Milbank-prison, Westminster, S.W., and 49, Grosvenor-road, Pimlico, S.W.
Hadfield, Robert, Newhall-road, Attercliffe, Sheffield.
Hassard, Richard, 1, Westminster-chambers, Victoria-street, S.W.
Henderson, William, J.P., Devanha-house, Aberdeen.
Michie, Alexander, 55, Leadenhall-street, E.C.
Miller, Captain David, R.N., United Service Club, Pall-mall, S.W.
Rayner, J., Town Clerk's Office, Dale-street, Liverpool.
Reynolds, Vincent John, Canon's-grove, Taunton.
Riego, Miguel del, 284, Regent-street, W.
Wragg, Robert Thomas, 7, Great St. Helen's, E.C.

The following candidates were balloted for and duly elected members of the Society:—

Crawford, Henry Homewood, 34, Moorgate-street, E.C.
Fuller, William J., Broad-plain Soap Works, Bristol.
Hargreaves, James, Widnes, Lancashire.
Herschel, Julius, M.D., 3, Adelphi-terrace, W.C.
Leverson, George Bazett Colvin, 18, Queensberry-place, S.W.
Manly, Thomas, 74, Park-road, Haverstock-hill, N.W.
Marshall, F. Herbert, Ormesby Iron Works, Middlesbrough.
Smith, Harry Turberville, 9, Great Marlborough-street, W.

The paper read was—

THE REFORMS IN HOUSE-CONSTRUCTION DEMANDED BY SANITARY SCIENCE.

By John Balbirnie, M.A., M.D.

A sanitary revolution in the architecture of the dwellings of the industrial and other classes is now imperatively called for, as one of the essential domestic necessities of this age. The houses of even the wealthy are far too often in flagrant antagonism to the first teachings of physiology—the basis of all sanitary science. As regards the working classes, how dear, in every way, to the general community, is the cost of the pestilent dens in which crowds of them are cooped

up in great towns, is a theme that needs not to be here enlarged on. Suffice it that Governments have awaked up to the magnitude of the evil, and have resolved to lay the axe to the root of the tree.

In what best way to replace effete tenements, and what are the most suitable buildings to fill up the new sites outside our great manufacturing centres, daily opening to receive an ever-expanding population—is an inquiry that constitutes the most pregnant social problem of the day—a problem in which, it is conceded, the sanitarian must go before and direct the architect.

In discussing this great topic it behoves, first, to unfold and insist on the radical alterations sanitary science dictates, as the regulating principles of construction in the future abodes of man, especially in closely packed populations; secondly, to reduce theory to practice on a small scale, until largely tested; in other words to illustrate the innovations called for by a series of plans and models.

Under the first leading head of discourse I shall take up, *seriatim*—

1st. The plan proper of a dwelling-house and its appurtenances; or the imperative domestic conveniences in a healthful and comfortable domicile, for any class of tenants.

2nd. The thorough ventilation of houses without cold draughts.

3rd. The heating of houses without expensive or easily deranged mechanism.

4th, and lastly. The cooling of houses, without risk or trouble, in hot seasons and climates. This last will be found an entirely new and hitherto unattempted branch of the architecture of the interior of houses, not to say of ironclads and other ships. This, in any case, will be a subject of interest to the rich denizens of the tropics.

The first subject of our programme is the proper arrangement of suites of apartments, larger or smaller, with their annexes.

The four essential compartments of a dwelling-house, in which there are at present radical defects, are—1st. The porch, lobby, vestibule, or entrance-hall. 2ndly. The staircase. 3rdly. The water-closet. 4thly. The subdivisions of the kitchen, or other rooms. Of course, all my observations refer to the close-pent houses of towns. These are of two classes; (*a*) massive "blocks" of many stories, for large numbers of tenants on one floor, under one roof, the "horizontal" or "flat" system, as it is called; and (*b*) houses less lofty, and less massive, in various degrees—the "perpendicular" system, where each tenant has his apartments one storey above another.

The porch, lobby, vestibule, or entrance-hall of a domicile, the common medium of access to its suite of rooms, should be the most carefully—I need not say the most tastefully—laid out portion of our domestic arrangements. Yet nothing has been more neglected. The majority of the houses of the working community, even of a steady, high-wage class, are without it entirely. This primary appendage and introduction to a healthy set of apartments should, in all cases, be well-lighted, and should open directly to the winds of heaven. As a rule, however, in the houses of well-to-do, or even wealthy people, it is confined and paltry in its dimensions, usually dark and gloomy, and unventilated, save in the short and spasmodic intervals of opening and shutting the main door. From this proceeds, often at two paces distance only, a steep staircase, like a ladder, direct, without rest or turn, to the floor above. In the artisans' houses, generally, this upper landing is a short *cul de sac*, without direct light or air. And be assured, wherever there is darkness, there is dirt and bad air! In the houses on the "flat" system—and they are by thousands in Glasgow and Edinburgh—the lobby has seldom anything but borrowed light, and not much of that. My plans and models will show how completely this may be remedied.

To recommend this portion of an architect's work to his most careful planning, it needs only to say, that it is to the household economy what the lungs are to the body—a direct ventilating medium, the indispensable aërating and purifying apparatus that prevents putrescence of the living fabric. This primary inlet and outlet of the domicile being so placed as freely to let in the light of day, and the air of day or night, is a guarantee for freshness of atmosphere.

From this showing, two things are clear—two great canons of construction are established, 1st., That the omission of architects and builders to do justice to the vestibule of a house is reprehensible, as failing to turn to account the first sanitary "coign of vantage" to be secured in a fitting residence, of whatever dimensions, for any class of people. And 2nd., that a well-placed, well-lit, well-ventilated entrance-hall should be the prominent feature, the distinctive peculiarity, the *sine quâ non*, of a thoroughly sanitary residence. We have accordingly given this, however humble the scale of dwelling, due and conspicuous place, in all the plans and models submitted for criticism. But how many, or rather how few, of even first-class town houses, have anything like adequate entrance-halls, well-lit and well-ventilated—not to say well-planned and well-adorned? As the class of building and of tenant rises, the greater the necessity for a fitting entrance, and the greater the scope for its size and ornamentation.

The staircases of our day and of past times come now to be reviewed. Here a fundamental and baneful error of construction has been perpetuated, I am sorry to say, in our recent "improved industrial" dwellings—even the dwellings of Mr. Peabody's trust, of Sir Sydney Waterlow, and others. It is to be hoped, however, that no future buildings of the sort will be disgraced by this error; nor the health of the occupants, as is too often the case now, compromised by preventible evils.

The staircases that concern us are divisible into two leading classes—1st, Those of large blocks for a multitude of tenants. 2nd, Those of single or "self-contained" houses. The great blocks have, for the most part, inner staircases; this in London almost without exception. In Scotland circular staircases to the back are very common; also square staircases to the front, but within the line of the front walls. In Paris, this square staircase is frequent, towards the back of the block, but not projecting beyond the walls.

Dr. Richardson has objected to these inner staircases on the best grounds. He declares them, as a rule, incompatible with the health of the inmates of the houses so reached; that such a construction is antagonistic to the first laws of

physiology; and this all the more the greater the number of single families that have apartments right and left off the landings of such stairs. These share among them a common lobby of access on each side of the stairs, and the lobbies are always dark and unventilated. The evils of this system may be readily conceived. Every time infectious disease prevails in any of these close-packed families—rather a frequent event—all the neighbours have a species of blockade to run every time they have to reach or leave their own dwellings. I have shown, by plans and models, how clumsy, dark, inconvenient, expensive, and unsanitary such staircases are, even when bettered by the best expedients, compared with the system I advocate of outside corridors or open galleries of access to the rows of apartments on each floor. These massive verandahs, or hanging balconies, strongly propped and tied, when of iron, from storey to storey, or solidly built, colonnade wise, in a more expensive style of house, I propose to be reached from a spacious staircase, quite through and through the block, made fire-proof, or by staircases attached to the back. For illustrations of these galleries and staircases, see the plans and models I exhibit. As a rule, these common centres and ways of approach to this community of tenants under one roof, should have their windows always open, or nearly so. In this way, there is no close or confined air about the back apartments, nothing approaching to the "stuffy" atmosphere of the central corridors of great hotels.

The second division of domestic staircases are those belonging to smaller blocks, containing individual or self-contained residences—the "perpendicular" system, so-called, where every tenant has two or more storeys for himself. This second category consists of four classes of stairs, and they all require entire reform. The first of these sub-classes occurs only in poor artisans' houses and in "Jerry" buildings. Such houses are usually built back to back, or, where a central wall longitudinally through the block divides the tenants into two distinct series, front row and back row. In all these cases there is a narrow, steep, dark, unventilated staircase leading to the storey or storeys above. This objectionable central staircase also obtains in a much better class of houses, where a front room and a back kitchen have corresponding rooms above them, with garrets and cellars.

The second sub-class is that I have already alluded to, where the staircase proceeds straight up from the front door, at a distance of two paces, to a dark, small, airless landing above. Such houses have often a room on each side on entering, and two corresponding rooms upstairs. These two classes of stairs are often closed up by doors, rendering them doubly dark and airless. The first should be abolished entirely, and the staircase made as I have shown in plan, leading up from the front door by a "well" six feet wide, and extending the whole depth of the dwelling. The front of this "well" upstairs is open to the day. In a better class of this sort there is a porch; over this, on the first floor, there is a bath-room and w.c., and a small passage with a window on each side, virtually detaching this necessary appendage entirely from the house.

The third sub-class of these objectionable staircases obtains in the mansions of the wealthy in our best streets. (Of course we are only here treating of houses built in rows.) I illustrate them by plans and sections cut out of a standard work in its day—*The Builder's Magazine*, 1788. The staircase is placed in the centre of the house, on one side of the entrance-hall, between the front and back apartments, and always lit by a close skylight. Here, as a rule, there is no pure air, and the odours from the kitchen and servants' rooms and offices in the basement are continually percolating into all the upper regions. A Howorth or Banner ventilator at the top, with air-inlets under the stairs on each floor, from front and back, is the only palliator of this faulty arrangement. But no houses henceforth should be built of this type.

The fourth sub-class of staircase is the best of this unhappy series, as admitting of direct light and air. It abuts upon the back wall of the house, is directly in front of the main door, and at the end of the entrance-hall. It only requires to be moved seven or eight feet farther back from the wall, to be in its right situation. Then it will give space for a w.c. and bath-room and an intervening passage of two, or three, or four feet, with its window on either hand, effectually isolating these conveniences from the main body of the building. This is the staircase that will henceforth obtain in the best class of houses. I recommend every second landing to be kept entirely open, for the purpose of forming a small conservatory or picture gallery; in either case, to flood with light the landings and central-halls of each storey. This should be still further effected by a dome-light at the top of the stair "well," with Howorth or Banner ventilator; and if without a skylight here, there should, at all events, be a ventilator through an aperture in the ceiling. In this way, there would be a regular exhausting medium of all the foul air of the house, an attractor of currents upwards from every lobby and apartment. This would tell in cold seasons, when all the windows were closed. In such houses, properly constructed *ab initio*, no one would ever breathe the same air twice, a sanitary consummation devoutly to be wished. And fresh air need not be frosty air. But of all this anon.

The position of the water-closet (including the bath-room) has now to be discussed. This necessary appanage of all dwellings, from the humblest up, should always have a window to the open air, also an intervening or intersecting lobby, with a window on each side wherever practicable, to give a through current. This will throw out a projection of at least six or eight square feet from the house, which projection may be utilised in many ways; below, for a porch or a scullery, above, for a conservatory or dressing-room, or a repetition of the bath-room and water-closet. These essential points of domestic convenience, comfort, privacy, delicacy, and self-respect have been too much neglected in times past by architects and builders. In very fine mansions in town and country we find the water-closet set in holes and corners, or off inner stairs and passages, mostly in central places where direct light and air were impossible. In hotels, hospitals, boarding-houses, hydropathic establishments, &c., these evils are rampant. In all places, the crowded

resort of human beings, the water-closet system should be quite detached from the main building. This has seldom been attended to. I have made it an essential feature of the large blocks planned and reduced to model, and proposed as the sort of buildings that may with credit and increased usefulness adorn the cleared "slums," and replace the departing "rookeries." The water-closets are near and easy of access to all tenants, yet sufficiently remote not to be a nuisance, nor are they so much in the way as to arrest attention. This is the only permissible arrangement for large working-men's blocks in the city, where land is dear. But in suburban districts and in newly laid out sites in the country every steady man of the working class should be in his own little castle—his house of two storeys, if only of four rooms. In this he should have *multum in parvo* of accommodation, but especially his bath-room and w.c.—the bath-room always, in any case from the time he can occupy the two-room dwelling of the large city block. But elsewhere, in the smaller blocks, the bath-room and the w.c. must always go together. Nothing will so enhance a man or woman's self-respect as this quiet, unobtrusive arrangement. The community of these essential necessities of civilised humanity is only tolerated in large establishments holding large bodies of people.

To sum up and emphasise my proposition on this head, I contend that it should be a grand architectural canon henceforth, that staircases, as a rule, should, in the houses in question, be at the further end of halls or lobbies leading directly from the front door, and that they should project at least seven or eight feet from the main wall, and should be, to all intents and purposes, insulated by an intervening passage continuous with the stair landing. At each side of this small passage should be a window, to ensure a through draught at command. This arrangement can be carried out without very much expense of time or material, or loss of ground, even in buildings of the humblest pretensions.

Before I conclude my strictures, it behoves me to describe a variety of innovations, introduced with the double view at once of economising space and saving the working man expense in cupboards, store-presses, or closets, wardrobes and drawers. I refer to the simple utilisation of the corners of apartments for the most part. Without much infringement on the actual usable space of a room, we may carve out three or four snug closets, two of them always with a window each to the daylight. Here we have virtual or real larders, sculleries, pantries, bath-rooms, wardrobes, store-presses, and closets galore, available in the humblest dwellings, of one or two "pieces," for the poorest working man—all indispensable conveniences of a household, now found only in tenements for a higher class, and here put up at very little expense, and therefore at only a small increase of rent. Even in houses of quality and pretence, for the same class of men when become rich masters, I have used freely these resources, especially in the arrangements of the kitchen.

All kitchens, I contend, no matter how spacious in closely packed town-houses, should have their corners so utilised. In one of these, with a window, should be the scullery with its sink and hot water tap from the close adjoining kitchen range. On the other side of the central window lighting the kitchen, should be the corresponding closet with its window, a convenient site for a supplementary kitchen, larder, or pantry, or both in one. In those cases the space in front of the kitchen window would give room for an ample table with drawers on one side, and a coal bunker on the other. All my plans are replete with these expedients for profitably using up vacant or superfluous space, where the necessities of the tenant require a series of conveniences to be placed at hand or within the smallest available limits.

The next great topic for discussion is the very pregnant one of ventilation. A safe and valid mode of introducing fresh air into our houses is the question of questions in domestic economy. Here an entire revolution is called for, and is at hand. The theory is all cut and dry, finished and perfect, to the satisfaction of any inquirer. All that remains now is to put the well matured plans into practice. Advanced as the present highly civilised era is in the arts of construction, and with the means of wealthy and polished communities at command, we are still far behind in the appliances for perfect ventilation. It is an easy thing in theory, and in fact, to ventilate a house by letting in floods of fresh air from an open window, or wall-openings, Sherringham, or otherwise. And, in fine weather, there cannot be too much of this—provided one keeps out of draughts. But when cold weather comes, cold air is eschewed as fraught with danger. And the prejudice is partly justified, because of the clumsiness of the fresh air expedients. Even our hardy soldiers, in cold nights, in model barracks (as I happen to know) prefer to stifle themselves—to close up all means of access of pure air, because it is cold, and they think riskful. Now the point to gain, and it is an easy point, is the construction of houses (whether on a large or small scale) on such a simple, inexpensive, universally applicable principle, that pure heated air in cold climates, and pure cooled air in hot climates, will be circulated throughout all parts of human habitations and places of assembly, by one identical machinery yielding at command a hot or cold fountain of supply, and this of all intermediate degrees of temperature, just as the necessities of the season dictate. This machinery, I say, in building a house, is inexpensive to construct, is liable to no derangements, and requires little supervision. My plans, models, dissected models, and diagrams show all this. By these improved methods, there will be no excuse, henceforth, either for bad ventilation, or the alternative evil of cold draughts, in our houses; nor will the atmosphere of a picture gallery, like the Grosvenor, as occurred one day there last summer, resemble that of the hot-room of a Turkish bath. To avoid breathing tainted air, people need not, after this, be exposed to the chances of chills and colds, of coughs and quinsies, of rheumatism and inflammation. I greatly mistake if an immense number of our finest buildings, our palaces, law courts, club-houses, colleges, picture-galleries, museums, theatres, concert-rooms, hotels, hospitals, churches, &c., will not demand to be fitted, at any expense, with the mechanism to these ends. But with new buildings, projected or started, and with our

embryo ironclads on the stocks, the incorporation with the architect's designs of a valid ventilating, heating, and cooling apparatus, pervading every department, chamber, and floor, will cost comparatively little time, trouble, or material to carry the new system into effect.

This question, then, of ventilating, heating, and cooling human habitations, I shall now discuss under one head, for they are but parts of one perfect system, the action of one identical mechanism, modified to meet the demands of varying seasons and circumstances. Nor, in all this, do I make any pretensions to novelty or discovery. I simply turn to account a great principle of circulation every day adopted in coal-mines, and which, moreover, has been well tested and attested for 40 years in the Pentonville Prison. The really wonderful thing is, that a simple, safe, sure, and inexpensive scientific expedient has not been largely applied by architects to the great public buildings above enumerated. If this hot or cold current never escaped from its flues, but merely circulated through hollow walls and hollow floors, from its entrance in the basement to its exit 30 or 40 feet above the roof, the atmosphere of the whole house, in every chamber, hall, lobby, and staircase, would be uniformly warm and genial in the coldest weather, and as uniformly cool and bracing in the heat of summer or the tropics.

Of this comprehensive circulatory agency, a grand central, all-commanding chimney, with a never extinguished fire near its summit, is the motive power—the medium of exhaustion or elimination of all the vitiated and residual air in every chamber, hall, passage, and staircase of the largest possible building. The walls are proposed to be hollow—to have a continuous interspace throughout of from four inches to a foot at an average, along which vacancy in the walls, and the same in the floors, a continuous stream, cooled or heated, or *au naturel*, is conducted from a chamber of supply in the basement, till it finds its exit by the great chimney—just as a river disembogues itself into the vast ocean—there losing all the foulness and all the *debris* it had swept down in its current. No one who understands mechanics will here presume to say that a hollow wall, or floor, or pillar, or girder may not be as valid support for the weight it has to bear as if made solid. This sort of thing applied to steam-ships will be much simpler work than in house construction because there, there is so much of hollow wall, and hollow floor, and hollow mast, hollow funnel, and hollow foundation (the kelson) that the whole art necessary is the fitting of holes here and there, to make the communications continuous; and this without infringing the integrity of its separate compartments. For the rest, there is the non-utilised draught up the funnel,—the *primum mobile*, henceforth, of a perfect system of ventilation, and of the circulation of cold or warm air in all steam-going ships, fighting or commercial.

As regards this power to pervade large or small blocks, or isolated houses, with pure air, cold or warm, I may remark that the central chimney force is imperative for the large blocks; but that in single self-contained houses on the "perpendicular" principle, the ordinary chimney-breast, with its flues improved and added to, will be perfectly competent to this grand domestic acquisition, the service of cold or warm air, *ad libitum*, throughout a household. This is no small recommendation of the system, as applied, on a small scale, to rows of houses, or self-contained villas and mansions of all sizes. In the case of the poor, we hope the day is at hand that ventilation will be made compulsory, as education is for the same class.

Anyhow, I have a firm conviction—and I want this recorded in all architectural books as coming from a physician—that the want of this grand desideratum of social life, a perfect system of ventilating, heating, and cooling houses, has produced more prostration, mental and moral, more suffering, more disease, and more deaths then all other causes of human deterioration and extermination put together.

The next important point that presents itself for elucidation is the production of the warmed or cooled air to be distributed through the flues pervading the building already described.

For the production of warm air, varied are the sorts of stove in use. The Constantine heating apparatus is, perhaps, as good as any yet in vogue. The objection to all these methods is the liability to superheat the air required, thus altering its chemical constitution, and vitiating its vital properties. The boiler I have devised, and which I shall presently explain at length, can never superheat the air, which passes through tubes filling up its interior, and making its escape into a spacious air-chamber, where the temperature can be regulated to a nicety before it is permitted to make its way into the flues in the walls and in the floors, in one or other, or in both, according to the requirements of the building. This boiler can be made large enough to heat uniformly throughout a house of the dimensions of the Charing-cross Hotel—this at an expense of 1s. or 2s. per diem in the coldest weather—or small enough for a cottage *ornée*. In the latter case, and with all self-contained "perpendicular" dwellings, the chimney breast, turned to due account, will perfectly suffice of itself.

The production of cold or cooled air is quite as simple. All that is here requisite is a storehouse of ice in an adjoining chamber. Through this, all the air passing into the chamber that in winter receives the heated air is first received, thus lowering its temperature to that of the coldest day in winter. Effectually to cool the entire house in the hottest seasons, this wintry atmosphere is made to circulate through the entire flue system of the block. If this be not sufficient to produce the desired coolness in any chamber, then the ventilators are opened, and in rushes any amount of cold air *ad libitum*. In any way, either for the production of a warm or a cold atmosphere in a house, this simple machinery is all-sufficient. Its grand recommendation is that it is not liable to derangement, requires little supervision, and entails but little expense once its necessary chambers and flues are properly constructed, in the original building of the house. The force in the great central chimney is a perfect guarantee that all the air in the house will be uninterruptedly determined to this outlet. In the primary receiving chamber of heated or cooled air, its dilution or tempering can be effected to any desired degree, by opening or closing the windows. The

model of the heating boiler is submitted to this Society. To show it in working order it should be placed on brick foundations. On these the furnace with its grating is laid. To economise fuel, the fire-place is of very small dimensions compared with the large under surface of the boiler. To bring the flames to bear upon this entire under surface, projecting flaps or flanges dip down across the boiler at half-foot intervals, from the entire bottom to near the red-hot coals, thus guiding the flames to the sides of the boiler, whence the smoke makes its escape into the flue of the chimney at the farther end. By making the air which enters the pipes in the boiler first be received through the arched brickwork of the ash-pit, an immense saving of heat is effected. Indeed, the air is half heated before ever it enters the boiler.* In summer this boiler is of course superseded, its exit into the reception chamber closed, and thenceforward cold air is let in from the ice-house, and this tempered to all degrees. The machinery of outlet into the house flues requires no modification. In steam-ships it is proposed that ice receptacles be placed in the kelson. Down through hollow masts (or tubes attached to solid ones) the air is received into the kelson chambers, whence, by appropriate pipes, it is distributed cold, or cooled only, through every part of the ship. Into a chamber emerging from the kelson the temperature desired is secured by necessary jets of hot air, either directly from without or from pipes passing through the stoke-hole. In this way all the drawbacks attaching to life on shipboard, whether from too hot or too cold atmosphere, and either impure, may be done away with. With perfect ventilation throughout our fighting ships, they would be doubly effective in warfare, and the invaliding of seamen immensely reduced.

We have, lastly, to discuss the improvements in "chimney-breasts," and fire-places, and grates, which are loudly called for at the present day, and which, if of the right sort, will do for small houses what the large central chimney, with its associated machinery, does for large blocks.

The chimney-breast is the prime part in the construction of a house. Made massive, and braced in by walls, right and left, front and rear, it is a true buttress for supporting the whole structure. This mainstay of a building, rightly made, will supersede the necessity for very strong walls, and, therefore, will be a great saving of time, of labour, and of material. But in its position, and in its construction and uses, great improvements are to be effected. Besides its smoke flues, it will be a conduit of warm ventilating shafts, and the appropriate receptacle of hot-air chambers, which should henceforth be attached to every grate. This chimney buttress, I contend, moreover, should be placed much more frequently than now in the corner of rooms. This will save space, often be a great convenience, and one chimney-breast of moderate dimensions will suffice for four rooms, separated by common walls.

The grand prevailing error in the construction of all fire-grates hitherto, and the cause of the failure of any grate deserving the prize in the late competition before the Society of Arts, is the use of the wrong material. A stove-grate merely for sitting-rooms, and not for cooking purposes, to be at once effective and economical, must for the most part be made of brick or terra-cotta, and only the bars iron; the brick or terra-cotta sides and top should be massive, in order to receive and retain a large amount of heat. For the same purpose, and to economise fuel, this massive grate-front should project from twelve to eighteen inches into the room. In this way the rays of heat will penetrate into every corner of a room and a smaller grate than ever before will suffice for a very large room. The objection hitherto to bringing a stove-grate far (or comparatively far) out into the room, is the liability to smoke. This objection does not hold with a closed stove; but certainly it has hitherto been a great drawback in the way of bringing open fire-places out a foot or two from the main wall or chimney breast of the room; but with the improvements I have made in the grate itself, and fire-receptacle generally, the draught is as perfect as with the best grate flush with the room-wall. A model is submitted. By the projection of its bars two inches beyond the plane of the grate-front, as now arranged, the power of heating the massive sides of the fire-place is doubled. By the whole contrivance the entire massive, projecting front of brick, or terra-cotta, is so heated that, if the fire is permitted to die quite out early of an evening, the chamber would keep up an agreeable temperature (as I have often proved by experiment), and this in the depth of winter. As for the ornamentation of this sort of grate, it will allow more scope than even any of the old-fashioned grates. The usual pilasters and marble sides and architraves of the chimney opening, into which the present grates are wedged, will not be interfered with. These, as heretofore, will admit the fullest skill of the sculptor, or the artist in Minton tiles, while the projecting surface, now an essential feature of the new grate, will afford a field for fresh sculpture, castings, and tilings. Nor need a highly ornamental grate in terra-cotta cost much; the real difference in price of the new grate and the old grate of similar style and workmanship being the difference of the price of clay as compared with that of iron ore.* It will be seen that the real fire-box of this grate is divided into a front and back compartment, the grated wall between them being at least four inches thick. Through these gratings the air rushes heated out from the narrow back chamber. An inch wide is sufficient. In this way, a continuous draught is solicited through the centre of the mass of coal on the fire. This terra-cotta or brick partition soon gets red-hot; not only giving out immense heat into the room at a minimum expenditure of coal, but the smoke, rising in front of it, at once breaks out into a flame in its passage, thus solving the long-vexed problem of

* By flues arranged under the furnace, the air necessary for the combustion of the fuel is made nearly red hot (if I may be pardoned that expression) before coming in contact with the coals. It is the hot blast in a most effective way.

* For all practical purposes at present, the commonest "sham" grate-front (so-called) answers admirably for the front of the improved grate. The sides and top of the projection may be "boxed in" with wood, or lined with marble or tiles. To give the whole of the new front the appearance of marble or alabaster when viewed at a little distance, I have it painted over with a mixture of starch one part, and whitening two parts. Two or three minutes once a week will suffice to renew this coating. Black-lead, and the slavery of 300 hours spent in a year in keeping a grate "tidy" I go dead against.

a smoke-consuming grate. But this smoke consumption is not perfect. On mending a fire, if done clumsily, the fresh coal in front will give out smoke for a little. Adroitly done, there is no smoke. The whole back partition-wall of the fire-place, and the chamber behind it, get so superheated, so red-hot in fact, that, in a few minutes, what would be a black smoking mass, for half an hour at least, becomes a bright and blazing fire. This so heats the whole chimney receptacle that the fire may be permitted to lower down almost to the point of extinction, before being fed with fresh fuel, and a very small quantity will then be found to suffice, if the winter weather be not very severe. From the back part of the fire I have made provision for coils of air flues discharging their warmed air at the sides of the chimney-breast; and other four air flues to proceed up to the ceiling, quite girding round with what engineers call a "jacket" the smoke flue, and absorbing as largely as possible all the superfluous heat, which must necessarily go up the chimney with the smoke. For a grate that will perfectly consume its own smoke, and allow but a trifling amount of heat to escape up the chimney, is a problem as hopeless to solve as that of the exact quadrature of the circle. Approximation to the mark is all that will ever be attained, and we have the firm confidence that the grate I suggest will, on the whole, be found more—much more—to economise the heat produced from a given amount of coals than any other open grate and fire-place yet propounded.

So much for part first of our programme. Part second will be ground much more easily gone over, and the details briefer. What now devolves is an explanation of the plans and models submitted to the Society, so far as they illustrate the principles of improved sanitary architecture we have contended for.

The first on the list of plans and models submitted represents a large block of six storeys high above the piazza or arcade of the ground floor, which is some 22 feet high, to allow for a mezzanine or entresol above the shops. This building has 192 single chambers for as many single men or women. These chambers are each about 13 ft. square and 10 ft. high. By utilising the corners, each has a small porch, a small larder, or closet, with a window in it, a small washing closet, with sitz bath, tap, or basin, with water laid on, and a sink. The fourth corner is appropriated to the fire-place. In the centre of the ceiling is a gas-jet, and above it an inverted funnel, opening into a four-inch tube leading into the chimney, so as to ensure the carrying off of the products of combustion, and the sucking up of all foul air generated in the room, by the unfailing centripetal draught in the chimney, whether there are fires in the chamber or not. The approach to these sets of chambers (which might be indefinitely increased in number) is along strongly fixed spacious iron galleries or corridors six feet wide, with three feet deep rail or parapet. An ample fire-proof staircase in the centre, through and through the block, leads up to the galleries on each storey. Opposite this, off the back gallery, at a distance of about twenty feet, is situated the water-closet system of the establishment, six to each storey. These are approached through a massive arch, the successive series of which arches support the great central chimney, in which all the flues terminate. At this converging point the fire-place is situated, the fire in which, being never allowed to be extinguished, is the guarantee for the unfailing circulation of air, and extraction of noxious gases through every part of the building. In this grand lodging-house no soul will ever breathe the same breath twice over, a consummation, I have already said, devoutly to be wished for in all the dwellings of man. When this is realised, then there will be an immense reduction even in the best standard rate of mortality. The 20 per 1,000 death-rate of the most favoured populations may be then brought so low as 10 per 1,000. These buildings are proposed to be fire-proof, their floors of rolled iron embedded in concrete. The roof of the same will allow of a spacious promenade and playground for children, and drying and bleaching plots for the washing of families inhabiting the block. Here also there is scope for an iron structure on the roof for a conservatory, lecture-room, music-hall, or concert-room.

The arcaded ground floor of this massive block is devoted to shops, including a restaurant, reading-room, co-operative stores, and Turkish bath, &c., this last convertible, one or two days a week, into a regular wash-house, with ample facilities for drying clothes—a new use for the hot room on supernumerary days. The shops of the ground-floor have each a stair, with windows to the daylight, for reaching the entresol story, and for descending into the kitchen, bath-room, larder, &c. The spacious back area of the basement makes the kitchens of the shops, &c., virtually on the ground floor. It may be as well here to remark that, to make a spacious eating-room and reading-room in the restaurant, the entresol floor is removed, giving those two rooms a height of 20 ft. The central compartment, or the bar of the establishment, and the rooms of service behind, are only of the height of the shops, and have their entresol with staircase to it.

It is to be hoped that such a utilisation of the ground floor of these massive buildings (which may be doubled in their capacity) will present attractions to countervail with the working man those of the gin-palace. Without leaving the cover of this great hive of industrial people, a man or woman may have a good breakfast of bread-and-butter and coffee for two or three pence; a dinner of beef and vegetables, and bread and pudding, for sixpence; and at the baths the refreshment of a cleansed skin, and, during the process, his or her clothes washed and dried into the bargain for another sixpence. And here the devotees of the weed may enjoy its luxuries in fairly good company. A very *élite* class of working men, undoubtedly, would compete for the comforts of the style of lodgings we here provide for them. The rents which the tenants of the *multum in parvo* shops could afford to pay would materially enhance the dividends yielded by this great social undertaking. I have said nothing about a great hydraulic lift from bottom to top of this great house. This would occupy just the space of a back or front tier of rooms, and, in the "family" blocks of the sort, would be in great demand, especially by the tenants of the more aërial regions. These family blocks, you will perceive by reference to the plans and

models, consist of two-room, three-room, and four-room dwellings, with porch, ample bath-room, scullery, larder with window, and closets in the corners of the bedrooms—two in each room, having windows. I trow that all this array of conveniences—only found in houses of much greater pretension and much higher rent—will be rather a new experience for working men in their early days of struggle with the world.

The next set of plans are drawn on the presumption that the working man prefers to live in some rural suburb. Here land is cheaper, and there is no longer necessity for huge town blocks. The rows of buildings may be only two storeys, but here he has his porch, where the street entrance would be otherwise direct into his parlour.

In some of these plans—the least to be recommended—I have shown the difficulty of dealing with the internal staircase, unless at a great expense. They abound in our large towns, in new as in old buildings, for the large poor class of people inhabiting them, and are always unlit, unaired, steep, and only three feet wide at the utmost. To make this sort of thing sanitary, the stair "well" between the front and back rooms must be six feet wide, at an average; and should consist of the double flight, and have a skylight—this skylight with a Howorth or Banner ventilator over it. The better sort of this class of building I have shown in the third series of plans, where a six feet wide staircase goes directly off the entrance hall, and ends on a landing in front directly open to the light and air of day, and having over the porch a bath-room and water-closet virtually cut off from the house. This is where there are two houses back to back, and there is a room and kitchen right and left of the entrance, and two corresponding bedrooms up-stairs. In all these cases an air-flue is led into each room or kitchen between the joists ending on the front or rear of the building respectively, to admit of ample through currents of air at all times when desired. Another kind of this class of four-roomed houses has one room to the front and another with back, and corresponding rooms up-stairs. Access to the upper storey may be made by a three feet wide stair in front, or one ascending from the back door. In a more stylish house of this smaller class the stair is six feet wide, projects from the back, has a scullery under the stairs on the ground floor; and off the upper landing, ascending by a few steps, there is the bath-room and water-closet. In this case the corners of the kitchen are so utilised as to make the kitchen completely circular—about 13 feet diameter. Here are all the conveniences a housewife could desire, viz., larder, store-closets, scullery, ample room for shelves, and for a sofa, and for a large table with a tier of drawers, and a coal-bunker to fill up the broad space before the window. The arrangement presented in this kind of house, I predict, will cause it to be a great favourite with good house-managers. Off its front bedroom, or in a three storey house, its drawing-room, there is a small conservatory whose floor is the roof of the porch below. I desire to direct the attention of architects, and builders, and connoisseurs to this plan, and the cognate ones for the comfortable artisan or small-salaried clerk.

The next class of houses is for men rising in the social scale. Some will prefer the "horizontal" system, or "flats," others the "perpendicular;" their apartments over each other. They leave the large many-tenanted blocks for greater retirement, and to be more "all to themselves," in their own houses, as they would express it. Here I have invoked the Scotch system of "flats," with improvements that make them as light and airy as cottages in gardens. These houses have usually a circular staircase attached to the back, but never yet that I have seen in the right place; the consequence is that the lobbies off these staircases are always dark, and with ventilation hardly thought of. I have given a plan of one of these houses, with each stair-landing giving entrance to two separate dwellings. Here, to each of these, there is a porch with its window, a lobby from this a-blaze also with direct light, and off this lobby a bath-room and water-closet, all but exterior to the house. Then there is a kitchen, parlour, and two bedrooms. A higher style of this house I give for a working man become a town councillor, or a flourishing master of his own works, or proprietor of his own shop. Here there is a spacious square staircase projecting from the back of the block, with only a single dwelling house off each landing. But this is replete with conveniences, and admits of the greatest elegance of detail. There is a very handsome vestibule, well-lit. From this there is an entrance to the kitchen, to a water-closet, and a balcony with a sink, and also a dust and ashes-shoot, and an entrance also to the saloon. This last room is expected only to belong to the mansions of the great, or to a Parisian house on the "flat" system. It has not been hitherto known in Great Britain as a feature of the class of houses I am now discussing. I have ventured to introduce it and to popularise it. The saloon here is a species of common room answering for hall, for reception, and for breakfast parlour, and dining-room. It is long, and ample, and well-lit, and communicates directly with every apartment in the house, and especially with a convenient pantry. This is another house which I venture to predict will become an immense favourite from its simplicity, its stylishness, its conveniences, its compactness, its privacy, and its comforts. This I have presented in model as well as in plan. Another class of this sort of house, but of yet higher pretensions, is that which is entered by square staircase to the front—projecting only a couple of feet from the main wall. Here is a small porch; then a large vestibule six feet wide; thence the kitchen, a bedroom, the saloon, and a bath-room, and water-closet, are entered. Off the long spacious saloon are three large rooms, all their doors symmetrically arranged. In all cases the extreme length of the saloon compared with its breadth is taken off, or masked, by a pillar and pilaster on each side in the appropriate spot for effect.

These and others, their congeners, are illustrations of houses of working men become rich, the aldermen, mayors, and master cutlers of their towns; and are for people who wish to combine the greatest quiet and privacy possible in a block of houses built for many tenants, but where the staircases are numerous.

I have now to speak of the most portly class of houses of all on the "flat" system, with only

one grand staircase in the centre of the block; and this giving access to spacious galleries or corridors on each floor, leading to a series, on either hand, of elegant suites of apartments, replete with every convenience. But I have ventured them no higher than six storeys above the ground floor storey. The galleries or corridors I propose should, in every instance, be massive stone colonnades (as shown in the models), and these held together strongly to the other walls by every resource of the builders' art. Had Sir Christopher Wren to live again, he would delight in this sort of construction, and would make it as strong in its supports—in proportion—as the dome of St. Paul's. Made fire-proof, and with ample hydraulic lifts, these buildings will inaugurate a new era in domestic architecture. In a more select class of this kind of building, I propose to have a series of staircases to each long block, because each landing is to give access to only two distinct residences—say of eight rooms each. This is the utmost limit this "flat" system will admit, without great loss of space. Besides, this kind of house is not intended for large families requiring numerous sets of rooms, but for a wealthy or reduced aristocratic, or for a literary or artistic class, who wish to dispense with keeping great establishments. The gallery colonnade of this best kind of "flat" house I call the "ambulatory," for such the Romans would have named it. Laid out in conservatory fashion, it would make a splendid hall of approach to the inner halls and apartments. The peculiar construction of Mr. Hankey's great house at St. Anne's-gate I have no idea of, never having yet seen it, or read any description of it. Only I am happy to learn that it answers as a speculation, and is in great demand.

Another class of this sort of building let me allude to, viz., that which will be wanted, by-and-bye, in the City, to replace many existing tumble-down tenements, and to line new streets. I speak of great commercial buildings, destined to be the offices of our wealthy merchants and eminent professional men, lawyers, physicians, surgeons, civil engineers, dentists; and why might I not say, noted tailors and dressmakers, and the most distinguished sons of St. Crispin? For all these are wealthy, and must keep up a-breast with the advance of the age, and be types and exemplars, even in their places of business, to those who are clambering up the same heights of ambition after them.

As a set-off against this really sanitary class of houses, I have made a series of plans and models of those with inner staircases—the impracticable, the unsanitary arrangement—and these will sufficiently answer their object of showing how not to do it.

The last class of large town houses to which I will here call attention is that of the true aristocratic or Belgravian mansion, improved by projecting the staircase 8 ft., at least, beyond the back wall—with bath-rooms and water-closets, and conservatories or picture galleries, on alternate landings. These plans and models will speak for themselves.

Finally, I have given plans to show how our most common rows of good houses, on the "perpendicular" principle, would be improved by throwing out the staircase 6 ft. or 8 ft. from the back wall. Every house on this principle, I contend, from the humblest up to the highest, should have its staircase thrown out as I have drawn, for the purposes of bath-room and water-closet, and the necessary insulation and through currents these claim and must have.

On the principle of a few voluntaries played off on the dismissal of a concert, I have given a few supplementary plans of some models.

1. There is the "new Albany"—a design for a building very much required—a series of first-class small suites of apartments for single gentlemen. The arrangement of these will, I believe, speak for themselves. There is also, or should be "an Albany for Benedicts without incumbrance," with precisely the same arrangements.

2. There is the plan and two models of an hospital on a small scale—showing how the grand central chimney mode of ventilation, and also the heating and cooling mechanism of houses, I have expounded, is to be applied practically.

3. There are the plans of a sanitarium on a large scale for first-class people, wherein all the advantages, without the drawbacks, of foreign travel and foreign residence would be realised more safely, and at less expense at home.

4. I have given the detailed plan of a portion of a sanitary suburb of a great town, with rows of model houses laid out in squares, with all the public needs of a community met in the shape of markets, washing, and bath-houses, restaurants, co-operative stores, churches, chapels, a museum, public hall, concert and ball-room, gymnasium, skating rink, dairy, tramway and its stables, *Maison de Santé*, lying-in-hospital, public park, allotment gardens, cemetery, &c.

Fifth and lastly, I have given a plan of an aristocratic suburb of a great city or town, with spacious streets and squares, and ample ground before and behind each house, for gardens, stables, offices, store rooms, &c.

To all these I invite the earnest and candid attention of architects and builders, and all sanitarians and philanthropists, and especially all managers of societies for improving the dwellings of the industrial classes. I believe I have contrived a set of houses so exactly in harmony with the requirements of sanitary science, and so in conformity with the tastes and needs of this cultured generation, that granting, for the sake of argument, that two miracles could be performed, first, that tens of thousands of these kinds of houses could be put up in a day in all parts of London and its outskirts; and secondly, that by another miracle, all landlords would consent on the next day to let off their tenants at an hour's notice, there would not in a week be a single one of these houses empty or unlet.

DISCUSSION.

Mr. Hale agreed that sanitation should go hand in hand with architecture, and thought it was astonishing that in the 19th century we had hardly made any progress towards building healthy houses. He should like to know whether any houses were to be seen built on this system in or near London; also whether they would be more expensive than ordinary houses; and whether the drainage was recommended to be in the front or back.

Dr. Lawrence Hamilton explained a new kind of

picture-frame which he had invented for use in hospitals, which would not hold any kind of infection, being formed of galvanised iron, and intended to hold two pictures, back to back, so that they might be changed to give a variety.

Mr. Cornelius Walford said he had learnt a good deal from the paper, but the fault he had to find with it was, that it had not attempted to improve the condition of houses at present in use. It seemed to be a new scheme for future generations, and he hoped it would be a benefit to them; but what he wanted to see was some system which would bring health and comfort to the present generation. Speaking of London houses generally, they seemed to him to show not the concentrated wisdom of the architectural profession, but their concentrated stupidity and utter want of knowledge of the laws of life and health. Any man who was obliged to live in London, and who knew the value of fresh air, must know the vast importance of having a simple means of producing a current of fresh air in his dwelling, and he hoped that before this subject was disposed of they would hear of some means by which this could be accomplished. If, in existing houses, nothing of that sort could be devised, he should feel that instead of getting further forward we were only going backwards.

The Chairman said the great practical difficulty lay in modifying existing houses so as to make them healthy and habitable. Dr. Balbirnie's scheme, if carried out on new ground, would be admirable in every way. He had looked through some of the models, and had gone very carefully through all the designs, and was bound to say that a better series of designs could not be put before an architect who was going to build a new town, or a new house on a large scale. There was something in every part which was worthy of attention, even in minute details; and they must all be grateful to him for entering so minutely into particulars. They could not expect in a place like London to see these improvements carried out on the scale he desired, any more than he (the Chairman) could expect to see a model city built. In all large towns there were three or four great difficulties to contend with. First of all there was the prejudice, or he might say conservatism, of the people; and the most simple improvements in houses were objected to by a majority of persons. Then there were the legal difficulties with regard to leases, and with regard to Board of Works, which stood directly in the way of every important improvement, and this must necessarily be so in a community like ours, where one depends so much upon the other; but Dr. Balbirnie had touched upon certain little things which might be introduced into every house, and were of great importance. He might refer specially to one word which carried a great deal with it. In these model houses he would have every second floor well ventilated by a little conservatory at the window. It answered very well and was inexpensive, and could be carried out without consulting the local surveyor. In some instances it would be well to put it on the first floor also, but, as a rule, on the second floor staircase window it was less obstructive to light, and there the ventilation was better than below, because the current of air brought from the basement and dining-rooms was carried off by the window instead of up to the top of the house. He had also referred to the introduction of Banner's ventilator, which was placed at the top of the house so as to ventilate it through the roof, and there was no doubt it was a very good plan in every house to have an opening at the top. In his own house he had introduced a pipe like a chimney shaft, which answered very well for the time. He tried the plan of withdrawing the air by suction, but it had disadvantages. If the draught were very perfect, it actually became the means of drawing air from the lower part of the house upstairs, and often produced a sharp current upstairs, which was unhealthy in cold weather. Therefore it was better not to exhaust the air directly in that way. It was very well to exhaust from the drains, but not directly from the top of the house. The warmth of the house would itself cause a current upwards. Another observation was made by Dr. Balbirnie with regard to draughts, and there was a practical difficulty in the present mode of ventilation, so that the soldiers who filled up the ventilators were not altogether wrong in very cold weather, because as much mischief might arise from colds taken in that way as from taking a moderate quantity of bad air. In fact, in the worst constructed houses you had the two evils together. A considerable amount of the consumption which was produced in this kingdom occurred in this way. The houses were both badly ventilated and draughty, and poor people passing upstairs were exposed to cold draughts, and then, having taken cold, they entered the close atmosphere, so that they got a cold, and this was premonitory of the disease which afterwards came from bad air. Ventilation and warming of houses was therefore a great desideratum, and Dr. Balbirnie had made a desired improvement in this respect. If he had done nothing more than refer to the admirable grate he had designed, his labour would have been well bestowed. At the present time there were four kinds of grates applicable for the purpose of warming and ventilating. There was Captain Galton's, which consisted of an iron box or flue at the back of the grate, in which the air brought from the outside was warmed, and whence it escaped to the upper part of the room. Then there was the admirable stove invented by Mr. George, called the "calorigen," one of which he had in his laboratory for some years, and a better system of warming and ventilating could not be adopted. There was a tube communicating beneath the floor with the external air, and bringing fresh air through a spiral over a gas flame whenever it passed into the room. There was also another stove, made on the same plan, where coal could be used as well as gas, and there was another, brought out by two gentlemen in Bridport, called the "comet" stove. It did not differ materially from the others except in this respect—that the space at the back was filled up by a fan of iron (iron branches spreading out like a fan) which communicated with the tube and went outside, and through these gills you got a current of warm air passing into the room. He had seen it at work in Queen-street, Cheapside, where one on the basement warmed both the room and the one above very well. But Dr. Balbirnie's plan was, after all, the best. It was always very objectionable to use iron for warming the air, especially if it were cast-iron, because a singular change took place in the air, when warmed in this way, by which its sustaining properties were much deteriorated. If it were plain sheet-iron, the evil was less, and still less if the iron were enamelled; but the heat was not thoroughly retained. The brick met this difficulty, and this simple process of building a large brick chamber with projecting brick surfaces, so that the whole heat produced by the fire was passed into the chamber, whilst fresh air from the outside was received at the back, was very simple, and merely involved bringing the grate further out into the room; and it had this advantage, that ordinary grates could be easily converted. He did not think it was really necessary to carry tubes from under the floors outside. Dr. Balbirnie said it was because then you were sure of getting pure air, and if any animal died under the floor you did not get the effluvium; there was also the advantage with a shaft of this kind, that you could open it at any time and place in it any suitable disinfectant, by which you could purify the room. But Mr. George came to the conclusion that bringing the air simply under the floor was a very good plan; it was very seldom that the accident of a dead animal occurred, and if plenty of openings were made to the open air, there was a good volume of air introduced, which was not always the case with a tube. Besides, it sometimes happened, as in his own house, that you could not introduce a tube, because

the rafters ran the wrong way. In building a new house, however, he should certainly introduce a shaft from the stove to the outside. The question of the staircase would always be a difficulty; in London houses there could not be a doubt that it was in the wrong place, and became a ventilating shaft for all the impurities in the lower part of the house. He had been trying to meet this difficulty in a variety of ways, but as yet without a perfect result. The nearest approach to a good result was in houses, where there was a fan-light over the door, to have the top row of panes made with openings of at least four inches, so as to bring in a steady current of good air, which would largely dilute the bad air. Another plan he had tried was to bring a tube from the top of the house all the way down, opening into the rooms and the staircase, and in that way, if you took care not to carry it right down into the basement, you might ventilate very well, the warmth of the house being sufficient to bring the pure air down. In our rooms, as now ventilated, the fault was there was often a good means of carrying away the bad air, but no fresh air was brought in. That was the case with the room they were in. Lastly, there came the question of the water-closet. In London and most large towns its position was abominable; sometimes it was close to the bedroom doors, and, practically, the difficulty of removing all nuisance was almost insuperable; indeed he could not say that he saw any way in which, in the majority of houses, it could be got over. He frequently met with cases where the water-closet was in the very bedroom. This was a constant source of mischief from the steady, slow, hardly perceptible ammoniacal exhalation which went on. The only way to at all meet the difficulty was by introducing a pipe from the outside under the floor, by having the most perfect communication with the soil-pipe, and by employing a thoroughly good trap—Underwood's being, in his opinion, the best.

Mr. Allen said he was the originator of the Waterlow buildings, and for five years was connected with the company. They were all constructed with balconies, were placed upon a good bed of concrete, and there was not an inch of drain under any of them. The soil-pipes were carried up through the roof, and through every room, by opening the windows, you could get a free current of air, which he considered was the best system. There were two sides to the question of patents. He invented a material and mode of construction for these buildings, which he patented, but in four years he threw it up and gave it to the public; the consequence was it was carried out in an imperfect manner by people who did not understand it, and the thing got a bad name. Many people told him it was no use, but where it was carried out under his direction it answered perfectly. Since he left that company, he had directed his attention to the suburbs, and he was quite convinced that they must adopt the "flat" system. He had carried that out in Manor-road, Stamford-hill, where he had at present four rows, the dwellings ranging from five rooms up to 12, and the rents varying from £25, £40, and £60 and in one case £80 per annum. The grounds were all in common, and the common idea that Englishmen would not adopt such a plan, but would insist on each having his own little garden to himself, was proved to be quite fallacious. They never had one to let, but they were sought for before they were finished, and the applicants were friends of the present tenants. One great advantage of the flat system was that it greatly reduced the cost. It was no matter how good a system might be, if it would not pay, it was of no use. By the flat system you reduced the number of bricks by nearly half, which was an important consideration. From a block of 90 ft. frontage, a rent of £250 was produced, which could not be done by the ordinary arrangement. Then, by putting as much as you could on the ground you reduced the quantity of water-pipes, gas-pipes, paving, &c. He could sit on a seat in his grounds, facing the opening between two blocks, and see for half a mile through the fields; and if this plan were carried out on a large scale you could have a large space of ground covered, and yet have currents of air freely passing in all directions. In building in the suburbs they wanted to start on a fresh system altogether. A few years ago, architects were all for breakfast parlours underground, but the public did not like them, and that plan was now abandoned; he was convinced that the flat system was the one of the future. In his buildings every tenant had his own separate entrance. There were no drains under the houses, and the ground was paved for four feet all round, so that the water all ran off. Very often houses were built with a wet course in the foundations, and then flower-beds were put close up to the walls, which held the damp. Another great advantage of the flat system was that the chimney shafts were carried up in the middle of the buildings, and thus a great deal of the waste heat was utilised in warming the rooms.

Dr. Balbirnie in reply, said his ideas were quite new; he merely proposed what he considered would be a very profitable thing in the construction of artisans' dwellings, especially since the Government had cleared some eleven sites, at an expense of nearly a million sterling, and the question was how best to fill up the blocks. He presumed that when Mr. Peabody left the large sum of money he did, it was for the purpose of erecting better buildings than could otherwise be put up, and to let them at the same rent as the old buildings. He had not gone into the drainage question, but certainly no drains ought to run underneath the houses. They might be either in the front or at the back, as was most convenient. There was a great difficulty in improving the present houses much, but something might be done to improve the warming and ventilating. This fireplace he proposed gave four currents of pure warm air, and anyone could introduce it at a very small expense, and obtain a grate which very nearly consumed its own smoke, and the saving would be immense. There was a difficulty in having open ventilators, and expecting that the hot air would ascend; it might in certain temperatures, but, as a rule, in cold weather, there would be a down draught, as he had practically tested in school-rooms and other places. By using a Banner cowl you ensured ventilation, but it required care or you would get a draught; hence the necessity for having heated air in the basement going through every room. The Government having purchased the sites, it was a question for the Metropolitan Board how far it might be worth while to give these plans a trial. They could not be undertaken by private speculators, whose chief object was to make a great deal of money by the investment, but the Government should not seek to make money out of the necessities of the people. This improved stove was much the same as the calorigen, but it had two advantages over it. The calorigen would do very well in a laboratory, but Englishmen liked to see a cheerful open fireplace; and another objection to it was that it was apt to explode occasionally; and people did not sit comfortably in a room where there was an idea that a barrel of gunpowder, or something equivalent to it, was in their midst. The fanlight ventilators he found answer very well in summer, but in winter they cooled the house too much. Still he contended that all houses for the artisan class, as well as shops, should have fanlights which could be opened or closed at pleasure. He had visited Mr. Allen's houses, and found them a great improvement on anything else in that shape; and, no doubt, if he had 50 to-morrow they would be caught up directly. They were admirably arranged on the flat system, but there was this objection, that they were not for the artisan class. In his plans he had arranged for four-roomed dwellings, some of them placed back to back, but in that case there was a shaft going through, so that there was practically air on each side of the room.

The Chairman then moved a vote of thanks to Dr. Balbirnie, which was carried unanimously, and the proceedings terminated.

MISCELLANEOUS.

SOCIETY OF ARTS PRIZE BLOWPIPE APPARATUS.

In the *Journal* for March 1st last, it was stated that the Society's silver medal and Col. Croll's prize of £10 had been awarded to Messrs. Letcher Brothers, of St. Day and Camborne, for their Blowpipe Apparatus, the best that was sent in for competition. Several improvements have since been made, and the following is a description of the standard box that has been deposited at the Society's house. The Messrs. Letcher guarantee that every box shall be equal to the one sent in.

The apparatus and re-agents are contained in a stained deal box, $10\frac{5}{8}$ ins. × $4\frac{3}{4}$ ins. × $3\frac{1}{8}$ ins., which weighs when full, 3 lbs. $9\frac{1}{2}$ oz. The box is provided with lock and key. It contains the following articles:—

1. Blowpipe.	22. Charcoal pastilles.
2. Spirit lamp.	23. Boiling dish.
3. Grease lamp.	24. Open tubes.
4. Hammer.	25. Closed tubes.
5. Anvil.	26. Glass rod.
6. Pestle and guard.	27. Blue glass.
7. Platinum forceps.	28. Litmus paper.
8. Brass forceps.	29. Turmeric paper.
9. Lamp tweezers.	30. Brazil wood paper.
10. Test tube holder.	31. Soda paper.
11. Chisel.	32. Carbonate of soda.
12. Magnet.	33. Microcosmic salt.
13. File.	34. Borax.
14. Scissors.	35. Bone ash.
15. Cupel striker.	36. Fluor spar.
16. Bone spatula.	37. Assay lead.
17. Platinum wire.	38. Nitrate of cobalt.
18. Platinum foil.	39. Bisulphate of potash.
19. Tinfoil.	40. Oxide of copper.
20. Magnesium ribbon.	41. Chloride of silver.
21. Pastille and cupel holder.	42. Potassic iodide and sulphur.

The first thing that attracts attention on opening the box is the mode of packing. Save the pastille box and holder, the glass tubes and holder, file, soda paper, and lamp tongs, all the apparatus and re-agents are contained in a wooden block with a variety of holes and recesses, each receiving a separate article. It is therefore simply necessary to lift out the block, and everything is set free, for none of the pieces of apparatus in any way interfere with each other. The repacking is effected quickly and easily, as each article fits into its own place, and an unfilled opening at once indicates that something is missing. If ordinary care is used, therefore, the traveller need not be afraid of leaving anything behind. No paper, wadding or pads are required, and yet the contents of the box are securely packed.

The blowpipe is made of brass, with a trumpet mouthpiece as recommended by Plattner; but the arrangement for getting rid of any moisture from the breath is novel, for the end of the moisture chamber is made to pull out altogether. The nozzle is of brass, but the Messrs. Letcher will supply others made of platinum at a small additional cost, probably about 2s., or rather less.

The lamp is one of the new grease lamps, which seem to be making their way into general use, for several of the boxes sent in for competition were supplied with them. Persons accustomed to oil lamps, candles, or gas, may find a little difficulty at first in using a grease lamp, but after a very few trials any trifling inconveniences will soon be overcome. The grease lamp is a small tin plate cylinder, with a broad flat wick on one side, and it is necessary, after lighting the wick, to take the blowpipe and direct the flame on to the grease until some of it is melted; after that the heat given out by the flame is sufficient to liquefy the rest of the grease, and the lamp goes on burning as long as there is any left. Messrs. Letcher's lamp will burn for more than two hours without requiring any further supply. Any sort of grease may be used, such as tallow, pieces of composite candles, night lights, or ozokerite. Of course oil answers perfectly well also, but then the advantage of the grease lamp is lost, which consists in the fact of there being no liquid to carry about when travelling. For hot countries a fat or mixture must be chosen which does not melt at too low a temperature. The cap of the lamp serves as a stand for it, and if greater height is required, as during a cupellation, for instance, the lamp may be placed on the box.

The spirit lamp is made of tin plate, which is calculated to resist rough usage better than glass; besides it enables the cap to be screwed on, and by means of a leather washer, any escape of spirit is prevented.

The hammer has an iron handle for convenience of packing. Messrs. Letcher's pestle and guard, when used on the anvil, form an arrangement like Abich's mortar, very useful for crushing hard minerals, especially when it is important not to lose any of the fragments.

The forceps used in testing the fusibility and flame colouration are made of steel, with pieces of platinum riveted on, and for all practical purposes are quite as useful as the more elaborate forceps supplied by the German makers.

The brass forceps are intended to fulfil several purposes. In the first place they serve, of course, for picking up small fragments of minerals, and secondly, they can be applied to uses first suggested by Major Ross. By means of a sliding loop of wire the forceps are converted into a clip for holding pieces of platinum wire while testing with borax or microcosmic salt. Then, if the wire is unfolded from the bead, it may be cleaned by being drawn through the broad part of the forceps. This is a "wrinkle" worth recollecting when travelling. Finally, the points of the forceps, when pressed together, form a long cone, round which the platinum wires may be bent again into loops of various sizes as required.

Articles Nos. 9 to 20 do not require any special remark.

No. 21 is a square prism of biscuit or unglazed porcelain, which is used as a support for the charcoal pastilles after having been blackened over the flame of the lamp. The blackened surface serves to catch the incrustation, whilst any sublimate near the assay is caught on the pastille itself, and can be there treated with nitrate of cobalt. In order to have sufficient surface for this test, it is advisable to place the assay near the edge of the pastille. It should here be stated that these pastilles and holder are merely a modification of those invented by Griffin many years ago; they differ from Griffin's in the fact of the pastilles being larger and the holders smaller.

The pastille holder is made to fulfil two other purposes: the unblackened sides may be used as streak plates, and a cavity at one end serves to receive bone-ash for cupellations. In an apparatus of this kind, intended solely for qualitative experiments, it was thought unnecessary to have the special cupel holder designed by Plattner, and it is found that cupellations can readily be performed on a little bone-ash pressed into the pastille holder with the cupel striker.

Turning to the re-agents, it will be found that there are the means of testing for all the common elements, though the experimenter who wishes to test for traces of nickel in the presence of much cobalt, manganese, or iron, will have to spend a few pence in buying a little bead of gold for collecting the nickel in the usual way.

The carbonate of soda is guaranteed to be free from

sulphur, and the assay lead from silver. The latter is is prepared by precipitation from the acetate. The assayer may therefore rest assured that any trace of silver that he finds was really contained in the ore tested and not in the re-agents used.

Enough has been said to show that the Messrs. Letcher supply a very good guinea's worth. They propose selling the same apparatus in a mahogany box at a somewhat higher price. As no London agent has yet been appointed, persons requiring the apparatus should apply to Messrs. Letcher Brothers, St. Day, Scorrier, Cornwall.

NATIONAL CULTIVATION OF MUSIC BY STATE AID.

At the meeting of the Manchester School Board, on the 29th April, Dr. Watts moved the adoption of the following memorial to the Education Department:—

That with a view to the improved teaching of music in public elementary schools, it is desirable that music be placed on the list of subjects encouraged by the Science and Art Department, and made specially applicable to pupil and assistant teachers, with a scale of grants similar to that specified for results in drawing, and your memorialists would urge that a great impetus would also be given to the popular study of vocal and instrumental music on scientific principles, were a scheme elaborated whereby certificates (similar to the "D" drawing certificate) could be obtained by teachers desirous of earning money by giving instruction in music in both its branches, with provisions for a partial certificate for either vocal and instrumental music similar to the provisions with regard to freehand and other drawing. That in pursuance of this opinion your memorialists have already established a class for the study of vocal music by notes, and have placed it under a competent instructor; but they consider it probable that comparatively little progress will be made until the cost of such classes is made merely nominal and the interest of elementary teachers generally in this subject is secured by the granting of public money for scientific tuition in music.

Mr. O'Reilly seconded the motion, which wrs unanimously adopted.

A correspondent draws attention to the fact that the Parliamentary estimates provide for an expenditure nearly reaching £100,000 a year, which at present produces little or no result. This movement at Manchester is, it is stated, likely to be followed by other School Boards in Lancashire.

CORRESPONDENCE.

INDIAN COMMERCIAL PRODUCTS.—BAMBOO.

With reference to Mr. Routledge's letter in your issue of 26th ult., I have to remark, that though I allow full weight to his argument for plantations, I limit such to the desirableness of a counterpoise to the native demands for cutting and bringing down the grass. What applies to the West Indies, or India itself as regards supply of bamboo, is small as compared with Burmah, where cutting can go on within a moderate distance of the ports for many years to come, and without the smallest reduction of annual supply.

When the "fibrous stock" proposed to be made from Bamboo shoots has attained the position in our markets it undoubtedly will, and the demand becomes, as for exports, great, then will be the time to shut the mouths of the native foresters by showing what can be done by plantations near a factory. The favourite employment of Burmans is that of "life in the jungle;" and in making contracts for the delivery of the grass at a factory, say within or under the price named by Mr. Routledge in his letter to your *Journal*, of 16th November last, I entertain no difficulty will be experienced, at any rate, for a long time to come, and when the to be looked for period arrives, and the ports of British Burmah can despatch to Europe one hundred thousand tons annually of fibrous stock, then, perhaps, Mr. Routledge's idea of plantations may be carried out to advantage, serving, as it might do, a wholesome check on the demands of the Burmese "Jungle Wallahs."

R. SPEAR BEGBIE.

April 29th, 1873.

DEPRECIATION OF SILVER CURRENCY.

Owing to my having been absent from home, I have only just seen Mr. Hendriks' letter in your issue of the 19th inst., commenting upon my reply to the objections raised against the paper I had the honour to read at the meeting of the Indian Section on the 29th ult. I hope you will kindly give me your permission to explain the further difference of opinion which he has therein brought to light.

Mr. Hendriks first says that he designedly omitted the "seigniorage," or charge for coinage, in calculating the value of the rupee, and he justifies this omission, as well as that of the unavoidable charges of transport, on the ground that the same "seigniorage" and charges might apply to a gold coinage struck in India, which, appearing on both sides of the equation, would thus leave the ratio between gold and silver unaffected.

If the comparison referred to were between the rupees of 1834 to 1873, and gold coins struck in India; and if it could be shown that the "seigniorage" and charges would be the same for both coins, then the argument would be important, but such is not the case. The comparison is with English money, and the point of difference is, whether the rupee was equal in "current" or exchange value to 1s. 10d. only, as Mr. Hendriks calculates, by omitting the necessary charges of transport and manufacture; or two shillings, as I have stated it to be, after allowing for them. Mr. Hendriks has reckoned only the London price of the raw material, which gives him the intrinsic value, in London, of the metal contained in a rupee. I, on the other hand, after adding all the necessary and unavoidable expenses of transport to India and coinage, arrive at the market or exchange value of the rupee in India. If a merchant sending out silver to be coined into rupees, and laid out in goods to be brought home for sale, were to calculate only the price of the bullion previous to despatch, he would, I think, not be very long before he discovered the very great mistake he had made.

The question at issue is the market or exchange value, stated in English money, of the Indian rupee in former years, previous to the present disturbance; and the view I venture to uphold is, that it is made up of the price in London of the raw material, plus the cost in English money of transport to India, and other charges, and manufacture there.

Mr. Hendriks endeavours to fortify his position by quotation from a work lately published by Mr. Rowland Hamilton, wherein the author has partially taken the same view as himself, by ignoring not the seigniorage, but the transport charges, in calculating the current value of the rupee. They seem both not to admit the fact that an article which costs 1s. 10d. in London, and is unavoidably subject to charges amounting to 10 per cent. of its value in transmitting it to, and preparing it for, a foreign market, must sell there for more than two shillings, or produce a loss. It is quite true that if any means could be found of transmuting silver bullion in London into rupees in India without any charge, it would require, as Mr. Hamilton states, its price in London to be a little more than 5s. 4½d. per ounce, British

standard, to make the rupee in India worth two shillings; but, although the expenses have been very greatly reduced since 1834, they are not yet annihilated, and until they are, the author's argument does not apply.

I am inclined to think that the last sentence in the quotation, viz., "The charges of transit should, in fact, be omitted as altogether irrelevant in fixing the relative values of the two metals at the same place, or at least charged equally," may mislead others besides Mr. Hendriks. It would be true if both metals came from the same source, and by the same means and expenses, but not otherwise; for instance, it could not be justly applied to a comparison of silver with gold, at Melbourne or in India.

But all this has nothing to do with Mr. Hendriks and my valuation of the rupee of 1834 in English money, nor with the question as to the proper valuation of a manufactured and exported article, as compared with the value of the raw material in the home market.

Mr. Hendriks evidently made a mistake as to the "seigniorage" charged by the Bombay mint in 1834. He says it is "news to him" that it was 4 per cent., and that he has a printed rule in his possession, dated 1875, showing the seigniorage on all except certain specified coins to be 2 per cent. No doubt this is quite correct; but my statement was that in 1834, not 1875, the charge made by the Bombay mint was 4 per cent.; and that is also quite correct. J. T. SMITH.

LIGHTNING CONDUCTORS AND GAS-PIPES.

Since my communication to the Society of Arts, concerning lightning-rod construction, on the 13th of March, I have come across a very instructive illustration of the principle stated in the paragraph numbered 31, on page 336 of the *Journal**.

The new church of All Saints' was opened in the town of Nottingham in the year 1864. The building has at its west end a tower, surmounted by a spire, which rises to a height of 150 feet from the ground. A four-tenth of an inch copper rope comes down from the weather-cock of the tower in a straight line, along its west face, to the ground. On the inside of the wall of the tower there is a gas-standard immediately opposite to the lightning conductor, and with four feet and a half of solid stone masonry between them. At the time of the completion of the building, there was a single burner in this gas-standard, upon the inner face of the wall, supplied by an iron gas-pipe from the main one inch in diameter, and about twelve feet above the floor of the church.

On the 16th of October, 1868, the spire of this church was struck by lightning, which passed harmlessly down the copper rope until within about six feet of the ground. It there, however, traversed the thick wall of stone masonry to get to the gas-pipe on the inner face, and scattered in fragments about a square yard of the stone on both the inner and outer surfaces of the wall, leaving a gaping crater on each face. About twelve inches of stone in the middle of the wall between the two craters sustained scarcely any damage.

When the bottom of the lightning-conductor was examined after the accident, it was found to be without any efficient earth-contact. It was cut off short just below the surface of the ground, and turned round a small stone. Mr. Hine, the well-known architect of Nottingham, who brought this case under my notice, and who very kindly took me a few days since to see the place, and to inquire into all the circumstances of the accident, tells me that there had been a fair earth-contact to the conductor in the first instance, but that a considerable length of the copper rope had been drawn out of the ground, and taken away by some thief.

On the day after the storm it was perceived that there was a strong smell of gas in the church, and a workman was sent down to examine the pipe near the meter, which was placed beneath the floor of the nave of the church, near to a south door. He took a light with him to test the soundness of the pipe, and the result was an explosion of gas which displaced a small portion of the floor, and some of the pews. The leaking of the gas had occurred in the pipe which connected the gas-standard on the wall of the tower with the meter. I could not actually ascertain that there had been any soft gas-pipe where the fracture had occurred, but an attendant in the church told me that there certainly was a short length of narrow pipe of some kind connecting the iron-pipe with the meter at the top.

At any rate there could be no doubt of the course which the electric discharge had taken. It had gone, just as it was bound to do, along the gas-pipe to the very large and complete earth-contact established by the gas service of the town, and it had made nothing in doing so of the intervention of a solid stone wall four feet and a half thick. On the whole it preferred having to get through that to the large and excellent earth-contact of the gas mains, to having to encounter the still more formidable task of squeezing its way through what may be termed the obstructed and almost blind termination of the rope. In this very instructive case the resistance, no doubt, was less through the stone wall and gas mains than it was through the constructed and inefficient termination of the proper conductor. The paragraphs No. 25 and 26 (page 336) of my paper are both very strikingly illustrated in this accident.

The copper rope, with a new piece twisted in at its lower part, still does duty upon the tower. This rope, it will be observed, is too small for its work, as there is only a diameter of four-tenths of an inch for a height of 150 ft. (see pars. 2 and 3, page 335), but it had, nevertheless, efficiently performed its office at the time of the accident until within 6 ft. of the ground. Neither the rope nor the building was injured above that point. The gas-standard and the iron pipe connecting it with the ground are still upon the inner face of the tower, but the pipe has been cut away from the main; obviously, not from any suspicion of the danger which it entailed, but on account of an iron stove for warming the church having been since fixed at this corner of the building.

ROBERT JAMES MANN, M.D.

5, Kingsdown-villas, Wandsworth-common,
April 29, 1878.

* *Journal of the Society of Arts*, No. 1321, March 15th, 1878.

GENERAL NOTES.

Statistics of New South Wales.—Gold—Area of gold-bearing formations, about 35,500 square miles, or 22,720,000 acres; area opened up but not worked out, less than 5,000 square miles, from which £32,000,000 sterling has been taken. Coal—Area of coal formation, about 23,950 square miles, equal to 215,328,000 acres. Tin—Area of known stanniferous deposits, about 8,500 square miles. Value of tin won, £1,867,410. The area opened does not exceed 8 square miles. Copper—Area of known cupriferous formations, about 6,713 square miles. Area opened scarcely appreciable. Value of copper won, £1,566,232. In the year 1876 there were 10,623 works and manufactories of all descriptions, and of these 49 were iron and tin works, 45 foundries, 2 type foundries, 144 coach and waggon works, 1 glass-silvering establishment, 6 ice works, 2 kerosene works, 2 paper mills, 99 ship and boat yards, 31 smelting works, and 2 steam joinery works.

The total of French imports and exports for 1877 was 7,240,691,000 francs, against 7,563,957,000 francs in 1876, a decrease of more than 300,000,000 francs. The excess of imports over exports was 272,045,000 francs, as against 412,000,000 francs in 1876. The chief diminution in exports was in manufactured objects—in imports, in natural products and materials necessary for manufacturing industries.

ADULT INSTRUCTION THROUGH PUBLIC MUSEUMS.

(Subsidised by Parliament.)

The following results, giving important information bearing on public education, are obtained as correctly as possible, from inquiry and Parliamentary returns, in the hope that they may hereafter be officially collected and published periodically, like the Registrar-General's returns. The number of visitors for the month of March, 1878, are stated. When they are counted by sight the letter "S" is used, when by turnstile the "M":—

Institutions.	Amounts voted in 1877.	Number of Visitors in March.	How counted.	Observations.
	£			
1. British Museum	109,990	38,368	S	Return refused. Open Mondays, Wednesdays, Fridays, and Saturdays. Closed, except to students, on Tuesdays and Thursdays. (1)
2. National Gallery, Charing-cross	6,976	87,036	S	Open Mondays, Tuesdays, Wednesdays, and Saturdays. Closed on Thursdays and Fridays. Open from 10 to 6. (2)
3. Kew Gardens and Museum	22,622	24,338	S	Open on Sundays and week days. (3)
4. South Kensington Museum	38,922	71,438	M	Open morning and evening till 10, on Mondays, Tuesdays, & Saturdays. Students' days—Wednesday, Thursday, & Friday, 6d. entrance. Open from 10 till Sunset.
5. Bethnal-green Museum	7,600	40,289	M	Ditto. (5)
6. National Portrait Gallery, South Kensington	2,000	..	M	Return refused. Open daily except Sundays. (6)
7. School of Mines and Mining Record Office, Geological Museum, Jermyn-street	8,997	4,924	M	Open daily, except Sundays and Fridays, and in the evenings till 10 of Monday, Tuesday, and Saturday. (7)
8. Patent Office Museum, South Kensington	..	15,527	M	Open daily, except Sundays. (8)
9. Edinburgh National Gallery	2,100	6,097	M	(9)
10. Edinburgh Museum of Antiquities	..	4,880	M	(10)
11. Edinburgh Museum of Science and Art	10,998	40,866	M	Open daily (10 a.m. to 4 p.m.) except Sundays, and Friday and Saturday evenings (6 to 9). Students' days—Monday, Tuesday, & Thursday; admission 6d.; other days, admission free. (11)
12. Edinburgh Botanic Gardens	1,750	6,949	M	(12)
13. Dublin Museum of Natural History	1,762	8,031	M	Open daily, & in the evening. (13)
14. Glasnevin Botanical Gardens and Museum	2,224	17,732	M	Open daily, including Sundays. (14)
15. National Gallery of Ireland	2,389	..	M	(15)
16. Museum of Royal Irish Academy, Dublin	300	..	M	(16)
17. Zoological Gardens, Dublin	500	7,950	M	Open daily, including Sundays. Number of visitors in July, 15,281. (17)
18. Tower of London	1,590	21,829	S	Open daily, except Sundays. (18)
19. Royal Naval College, including Greenwich Painted Hall	38,051	29,253	S	Open daily, including Sundays. (19)
20. Royal Naval Museum, Greenwich	1,055	2,941	S	Open daily, except Fridays and Saturdays. (20)
21. India Museum, South Kensington	..	1,238	M	Paid for by Indian Government. Open on Mondays, Tuesdays, Fridays, and Saturdays, 1d. admission; on Wednesday and Thursday, 6d. admission. (21)
22. Hampton Court Palace	7,475	3,966	..	Open on Sundays, and on week days except Fridays. (22)

(1) The numbers are those for the corresponding month of the previous year, as given in the Parliamentary Return.
(2) Open to the public 17 days, from 10 to 5 o'clock.
(7) Number of visitors in the morning, 2,500; evening, 2,424—total, 4,924.
(8) Total number since the opening of the museum (12th May, 1858), free daily, 3,889,016.
(13) Visitors in the daytime, 2,359; evening, 5,672—total, 8,031.
(14) Visitors on Sundays, 12 940; week-days, 4,792—total, 17,732.
(15) (16) No information as to opening.

NOTICES.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at eight o'clock.

May 8.—"The Phonograph, or Talking Machine." By W. H. Preece, Esq. Mr. Alderman and Sheriff Nottage will preside.

May 15.—"Dietaries, in their Physiological, Practical, and Economic Aspects." By R. M. Gover, Esq., M.R.C.P., Lond.

May 22.—"Controlling and Correcting Clocks by Electricity." By Frederick J. Ritchie, Esq.

African Section.

Tuesday evenings, at Eight o'clock.

May 28.—"A Year on the Nyassa, with Notes on the Slave Trade, and on the Prospects and Means of Opening up the Surrounding Country." By H. B. Cotterill, Esq.

Chemical Section.

Thursday evenings at eight o'clock.

May 9.—"Some Recent Improvements connected with Alkali Manufacture." By James Mactear, Esq.

May 23.—"The Position of Chemistry in a System of Technical Education, as illustrated by some of its applications." By J. M. Thomson, Esq., F.C.S., of King's College, London.

Indian Section.

Friday evenings at eight o'clock.

May 3.—"The Telegraph Routes between England and India." By Major Bateman-Champain, R.E. Lord William Hay, F.R.G.S., will preside.

May 17.—"Agriculture in India." By F. C. Danvers, Esq.

Cantor Lectures.

Monday Evenings, at Eight o'clock. The Third Course, for the present Session, will be on "Some Researches on Putrefactive Changes, and their Results in relation to the Preservation of Animal Substances." By B. W. Richardson, Esq., M.D., F.R.S. The Third Lecture will be delivered on Monday, May 6; the dates for the remaining Lectures will be as follows:—May 13, 20, 27.

Members can admit one friend to each lecture. Books of Tickets for the purpose were supplied to all the Members at the commencement of the Session.

MEETINGS FOR THE ENSUING WEEK.

Mon..... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Dr. Benjamin W. Richardson, "Some Researches on Putrefactive Changes, and their Results in Relation to the Preservation of Animal Substances." (Lecture III.)
Farmers' Club, Caledonian Hotel, Adelphi, W.C., 5½ p.m. Mr. W. E. Little, "Local Government, with Especial Reference to Rural Districts."
Royal Institution, Albemarle-street, W., 2 p.m. General Monthly Meeting.
Society of Engineers, 6, Westminster-chambers, 7½ p.m. Mr. Henry S. Copland, "Modern Roadway Construction."
Royal United Service Institution, Whitehall-yard, 8½ p.m. Adjourned discussion on "Saving Life on Board our Men-of-War."
British Architects, 9, Conduit-street, W., 8 p.m. Annual Meeting.
Medical, 11, Chandos-street, W., 8.30 p.m. Annual Oration and Conversazione.
Victoria Institute, 10, Adelphi-terrace, W.C., 8 p.m. Prof. J. L. Porter, "Physical Geography of the East."

Tues.....Central Chamber of Agriculture (at the House of the Society of Arts), 11 a.m.
Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. T. Thistleton Dyer, "Some Points in Vegetable Morphology." (Lecture II.)
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Discussion on "The Ravi, Alexandra, and Jhelum Bridges;" and, time permitting, Mr. J. Fortescue Flannery, "The Construction of Steam Boilers for very High Pressures."
Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.
Photographic, 5A, Pall-mall East, S.W., 8 p.m.
Biblical Archæology, 33, Bloomsbury-street, W.C., 8½ p.m. Rev Albert Löwy, "Kurdish Folk-Lore in the "Kurdo-Jewish Dialect, with Philological Observations."
Zoological, 11, Hanover-square, W., 8½ p.m. 1. The Secretary, "Additions to the Menagerie in April, 1878." 2. Mr. T. Jeffery Parker, "Note on the stridulating organ of *Palinurus vulgaris*." (Received 27th March, 1878.) 3. Dr. F. Buchanan White, F.L.S., "Contributions to a knowledge of the Hemipterous Fauna of St. Helena, and speculations on its origin." (Received 8th April, 1878.)
Royal Horticultural, South Kensington, S.W., 11 a.m.

Wed..... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. W. Preece, "The Phonograph, or Talking Machine."
Geological, Burlington House, W., 8 p.m. 1. Mr. James Geikie, "The Glacial Phenomena of the Long Island, or Outer Hebrides." 2. Mr. James Croll, "Cataclysmic Theories of Geological Climate" Communicated by Prof. A. C. Ramsay. 3. Mr. T. F. Jamieson, "The Distribution of Ice during the Glacial Period."
Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m.

Thur. ..SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Chemical Section.) Mr. James Mactear, "Some Improvements connected with Alkali Manufacture."
Royal, Burlington House, W., 8½ p.m.
Antiquaries, Burlington House, W., 8½ p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Colour." (Lecture II.)
Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.
Royal Historical, 11, Chandos-street, W., 8 p.m. 1. Rev. Prebendary Irons, "The Transition from Heathen to Christian Civilisation, from the Times of the Antonines to the Fall of the Western Empire." 2. Mr. Cornelius Walford, "Early Bills of Mortality." 3. Rev. Charles Rogers, "Historical Memorials of the Abbey of Cupar-Angus."
Mathematical, 22, Albemarle-street, W., 8 p.m.

Fri.......Royal United Service Institution, Whitehall-yard, S.W. 1. Colonel Edward Clive, "The Influence of Breach-loading Arms on Tactics, and on the Supply of Ammunition in the Field."
Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Sir William Thompson, "Effects of Stress on Magnetisation of Iron, Nickel, and Cobalt."
Astronomical, Burlington House, W., 8 p.m.
Quekett Microscopical Club, University College, W.C., 8 p.m.
Clinical, 53, Berners-street, W., 8½ p.m.
New Shakespeare Society, University College, W.C., 8 p.m. Mr. T. Alfred Spalding, "The Devils in Shakespeare."

Sat....... Physical, The Science Schools, South Kensington, S.W. 3 p.m.
Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Henry Morley, "Richard Steele." (Lecture II.)

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,329. Vol. XXVI.

FRIDAY, MAY 10, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

NATIONAL WATER SUPPLY.

Committee.—Major-Gen. F. C. Cotton, R.E., C.S.I. (Chairman of the Council), W. Hawes, F.G.S. (Deputy-Chairman of the Council), F. Abel, C.B., F.R.S., Alexander H. Brown, M.P., James Caird, C.B., E. Chadwick, C.B., Lord Alfred Churchill, Hyde Clarke, Sir H. Cole, K.C.B., Capt. Douglas Galton, C.B., F.R.S., Sir U. Kay-Shuttleworth, Bart., M.P., R. W. Mylne, F.R.S., F.G.S., Admiral Sir Erasmus Ommanney, C.B., F.R.S., Prof. Ramsay, F.R.S., F.G.S., R. Rawlinson, C.B., T. R. Tufnell.

The Congress will be held on Tuesday and Wednesday, 21st and 22nd May, 1878, at 11 o'clock.

The object of the Congress is to discuss the question of a comprehensive scheme of National Water Supply, "with a view to the consideration of how far the great natural resources of the kingdom might, by some large and comprehensive scheme of a national character, adapted to the varying specialities and wants of districts, be turned to account, for the benefit, not merely of a few centres of population, but for the advantage of the general body of the nation at large," as suggested in the letter of H.R.H. the Prince of Wales, President of the Society, in which the subject was first brought to the notice of the Council of the Society.

Papers, prepared at the request of the Council, will be printed and circulated at the Congress, and discussion will be taken upon them.

HEALTH AND SEWAGE OF TOWNS.

Executive Committee.—Major-General F. C. Cotton, R.E., C.S.I. (Chairman of the Council), W. Hawes, F.G.S. (Deputy-Chairman of the Council), F. A. Abel, F.R.S., Lord Alfred Churchill, Sir Henry Cole, K.C.B., Col. Sir E. Du Cane, K.C.B., Capt. Douglas Galton, C.B., F.R.S., T. W. Keates, Dr. Voelcker, F.R.S.

The Conference on this subject will be held on Thursday and Friday, 23rd and 24th May, 1878, the Right Hon. James Stansfeld, M.P., late President of the Local Government Board, in the chair.

Programme of Proceedings.

The Conference will meet each day at 11 a.m., and will sit till 1.30, then adjourn till 2, and sit again till 5 p.m., and if necessary, meet again at 8 p.m.

Thursday, 11 a.m.—Opening of the Proceedings by the Chairman. Papers and discussions on—

1st. Public Health as Affected by various Treatments of Sewage.

2nd. Gradual Abolition of Cesspools and Middens, and Substitution of Tubs and Pails with speedy removal.

3rd. Whether any further Legislation, of a Compulsory or Permissive Character, is needed for bringing about a better Sanitary Condition of Towns or Dwellings.

4th. Progress, if any, made in the Utilisation of Excreta since the last Conference.

5th. Progress, if any, made in Treating Water-carried Sewage since the last Congress.

6th. Escape of Sewage-gas into Dwellings, and Modes of Prevention.

7th. Discharge of Sewage into Sea.

8th. Cost of Systems given in the last Report of the Local Government Board.

Friday, 11 a.m.—Proceedings will be resumed. Papers and discussions continued.

Papers on any of the above heads are requested.

There will be an Exhibition of Appliances connected with Sanitation and Water Supply. Manufacturers and others desiring to exhibit should communicate forthwith with the Secretary of the Society of Arts.

PARIS EXHIBITION.

The following letter has been received by the Secretary:—

40, Avenue de Suffren, Paris,
May 8th, 1878.

Sir,—I am directed by H.R.H. The Prince of Wales to acknowledge the receipt of your letter of the 16th April, on the subject of a formation of a committee of her Majesty's Commissioners to associate with a committee of the Society of Arts to promote the visit of artisan reporters to the Paris Exhibition.

I am to inform you that the names of her Majesty's Commissioners appointed for this purpose are as follows:—The Earl Spencer, K.G., The Right Hon. Lyon Playfair, C.B., M.P., Mr. Sampson Lloyd, M.P., Mr. Hugh Birley, M.P., Mr. Joseph Chamberlain, M.P., Mr. Samuel Morley, M.P., Mr. John Mulholland, M.P. Mr. A. J. Mundella, M.P.

I have the honour to be, Sir,
Your obedient servant,
P. Cunliffe Owen.

P. Le Neve Foster, Esq., M.A.

INDIAN SECTION.

Friday, May 3rd; Lord William Hay, F.R.G.S., in the chair.

The Paper read was—

THE TELEGRAPH ROUTES BETWEEN ENGLAND AND INDIA.

By Major Bateman-Champain, R.E.

Although I have undertaken to read a paper on "The Telegraph Routes between England and India," I am fully conscious of the impossibility of here dealing with so comprehensive a subject in anything like an exhaustive way.

Much time might be usefully devoted to a discussion of many minor but intrinsically important questions which naturally arise out of a consideration of long telegraphic lines in general, or of the lines to India in particular. But in the following pages I must confine myself to a mere sketch of the origin of the carrying out of the lines, and of their present condition and prospects; and touch but superficially on such points as the following, viz.:—

The geographical conditions of the countries and seas traversed.

The form and quality of the material employed.

The means adopted in making and laying the several cables.

The precautions requisite for maintaining sea and land telegraphs.

The terms of the various concessions and of the agreements with the different States and companies interested.

The tariffs in force.

The standards by which messages are taxed.

The speed attained in transmission, and so on.

Leaving such matters to be treated of elsewhere in more technical fashion, I hope to be able to lay before you a tolerably distinct general narrative of a business with which, for 16 years, I have had the honour of being closely connected.

It is not necessary to attempt a detailed account of the many schemes for establishing telegraphic communication with the East, which have for more than 20 years engaged the attention of the different interested Governments on the one hand, and of telegraphic promoters and engineers on the other, But a rough sketch of the first steps which led to the organisation of the existing lines may be of interest, and will not occupy much time.

Those who wish to closely study the matter *ab initio* will find complete information in the Parliamentary Blue-book, entitled "Correspondence Respecting the Establishment of Telegraphic Communications in the Mediterranean and with India," dated 4th May, 1858; in the "Report of the Joint Committee on Submarine Cables," presented to Parliament in 1861; and in the "Report of the Speccial Committee on Telegraphic and Postal Communications between this country and India," dated 20th July, 1866.

Obvious geographical considerations pointed, of course, from the first to the Red Sea and to the Persian Gulf, as the two main routes to be examined in relation to the telegraph between England and India, and each route had its ardent supporters.

On the 1st June, 1855, the Court of Directors of the East India Company, in a letter addressed to Mr. Lionel Gisborne, expressed their deep interest in a proposal put forward by that gentleman to organise and construct a line of telegraph *viâ* Constantinople to Alexandria, and added that they would be ready to consider in a liberal spirit the proposition to continue the line to India.

About the same time the Persian Gulf route was strongly advocated, one of its warmest supporters being Sir William O'Shaughnessy, the distinguished chief of the Indian Government telegraphs, who, in January and February, 1857, submitted to the Court of Directors some carefully considered suggestions for the manufacture and submergence of a cable between Bussorah and Kurrachee, in connection with the projected land lines of the Euphrates Telegraph Company. Sir William O'Shaughnessy had previously given his reasons for preferring, as a cable route, the Persian Gulf to the Red Sea, dwelling strongly on the intricacies of the latter's channels and dangers (from coral reefs and sudden changes of soundings) to which a submarine wire would be exposed between Suez and Aden.

These two schemes undoubtedly contained the germs of the systems now in operation.

The outbreak of the mutiny of 1857 impressed more strongly than ever on the authorities the absolute necessity of improving at any cost the means of communication between Great Britain and her Eastern possessions, and in the summer of 1858 the Government gave an unconditional guarantee of $4\frac{1}{2}$ per cent. for 50 years upon the whole capital required for the construction of the Red Sea and India line. This capital was £800,000. Mr. Lionel Gisborne was the engineer, and Messrs. Newall and Co. the contractors, and the results of this enterprise cannot be better summed up than in the words of the Joint Committee report, which run as follows:—

"The cable consisted of a strand of seven copper wires, weighing 180 lbs. per nautical mile, covered with two coats of gutta-percha alternated with two coats of Chatterton's compound, weighing 212 lbs. per nautical mile. This core was served with hemp yarn tarred, weighing $1\frac{1}{2}$ cwt. per nautical mile, protected by iron wires, weighing 16 cwt. per nautical mile. This cable had consequently the largest copper conductor and the best insulation of any cable made up to that date. The whole length of line is 3,043 nautical miles.

"The first portion, between Suez and Aden, was finished on the 28th May, 1859. It was laid in three sections, exclusive of the land line between Alexandria and Suez. The first section is from Suez to Cossire, 255 nautical miles in length; the second, Cossire to Suakin, 474 miles; the third, from Suakin to Aden, 629 miles in length. The portion of cable laid between Suakin and Aden tested much less perfectly before it was laid than the other two portions. The section from Suez to Cossire was in good order when laid. There was a fault on the Cossire-Suakin section, 135 miles from Suakin, when first laid, but not such as to prevent the line working, and for several months it did not get worse; the line has, however, since failed.

"In February, 1850, the Aden-Suakin section failed, and it was found to have several faults; one appeared to caused by the gutta-percha having been softened by heat, and the yarn having cut into it and bared the copper wire, and there appeared to be a defect caused by the flange of a drum having rolled over the core and cut into the copper wire, apparently before the core had

been covered with yarn and wire. The company endeavoured to repair the section, and laid down for the purpose above 300 miles of new cable. The communication was restored in July. The section, however, failed again five days afterwards. The pieces brought up from this portion of the cable showed numerous places where the wire covering was entirely corroded away. In other places the wires were as good as when first laid. In many places the cable was entirely covered with shells and weeds, and thus protected from corrosion. This section was laid very taut, and some of the injuries have been attributed to tight paying-out, but the corrosion of the outer covering would to some extent account for the appearance of the pieces which have been brought up. Faults have also appeared in the Suez-Cossire section.

"The second portion of line between Aden and Kurrachee was completed in February, 1860, but remained only for a short time in working order. A portion, of about 70 miles, is laid in depths of from 1,900 to 2,000 fathoms. The sections on this line are from Aden to Hallain, 718 miles; from Hallain to Muscat, 486 miles; from Muscat to Kurrachee, 481 miles. The Aden-Hallain section has a fault supposed to be about 230 miles from Aden. The Hallain-Muscat section is stated to be in good working order. The Muscat-Kurrachee section has a fault close to Kurrachee, supposed to be caused by injury to the shore ends from waves; but it would appear also to have other faults.

"The company have had no means on the spot for the repair of this line, nor have they a staff competent to give the information required to enable the condition of the line to be ascertained with accuracy; but there can be no doubt that, with a moderate expenditure and proper appliances, it would be capable of being made some use of.

"It appears that the contract provided that the cable should be maintained in working order for 30 days by the contractor, and that the several separate sections were worked for a longer period, but that the whole was not worked throughout for that period. The speed at which messages could be sent through the longest section, viz., from Aden to Hallain, is stated by Mr. Forde to be about five words per minute, but we believe that with proper appliances the line would give a higher speed. We consider that the failure of this line is attributable to the cable having been designed without regard to the conditions of the climate or the character of the bottom of the sea over which it had to be laid; and to the insufficiency of the agreement with the contractor for securing effectual supervision during manufacture, and control of the manner of laying. It is moreover to be regretted that the contract for laying this line was entered into without a full investigation into the question, considering that the success of the Atlantic cable was at the time very doubtful."

While these operations were in progress, the Government had not relaxed its efforts to arrive at some satisfactory arrangement with Turkey as regards the establishment of through telegraphic communication between Europe and India, by way of Mesopotamia and the Persian Gulf. The Indian Government was prepared on its part to lay a cable from Kurrachee, to the mouth of the Shat-el-Arab, if the Ottoman Government would provide a secure line thence to Constantinople. Since August, 1858, Colonel Biddulph, of the Royal Artillery, had been actively engaged in the construction of the land line across Asia Minor, aided by some 10 or 12 Englishmen, amongst whom were Messrs. Carthew and McCullum, retired non-commissioned officers of the Royal Artillery. In February, 1859, however, Colonel Biddulph found himself compelled, from illness and other causes, to resign his charge, although the greater number of his subordinates remained to carry on the work under the Turkish Government.

In October, 1859, Sir Henry Rawlinson's efforts at Constantinople in connection with the matter led to a Convention being prepared by the Porte and sent to London for consideration. The line of telegraph was soon afterwards completed by the brothers McCullum and Mr. Carthew as far as Baghdad. Between that city and the sea lay 500 miles of desert, inhabited by turbulent Arab tribes, frequently in revolt against their Turkish rulers, and most difficult to depend upon as regards the safety of a wire traversing their country. This Baghdad-Bussorah section indeed promised to be the weak link in the chain of communication, and much discussion took place as to whether a subfluvial cable down the Tigris would not be less exposed to attack, and consequently preferable, to an aerial wire. Eventually, however, the latter was approved.

Towards the close of 1860, Colonel, now Sir Arnold Kemball, accompanied by Mr. Greener, a well-known telegraph engineer, as his professional adviser, rode over the line of telegraph from Constantinople to Baghdad, and on the 7th May, 1861, submitted a complete report on the conditions and prospects of the Turkish route; while somewhat similar expeditions were undertaken further east by Colonel, (now Sir) Henry Green, and Major (now Sir) Frederick Goldsmid.

The disastrous failure of the Red Sea cable had thoroughly convinced the authorities of the necessity of a vigorous prosecution of the other scheme. The Government of India decided in the case of this second attempt to employ the services of their own officers, and to work independently of companies and contractors. The conditions of the enterprise were now fairly understood, thanks to the careful inquiries of the officers already named, and early in 1862, Lieut.-Col. Patrick Stewart, of the Bengal Engineers, was selected as the chief to whose ability and judgment the work was to be entrusted. It would have been impossible to find elsewhere a man so admirably fitted for the task. To quote the words of his successor, "As Col. Stewart became better known to the authorities presiding over or eminently connected with British interests in the East, he was pronounced competent to advise, to guide, to represent his Government. In two short years from the time of his summons to the work, he had accomplished the main object required. The reins once committed to his hands, he disentangled them, and drove his enterprise to success."

In the spring of 1862, Col. Stewart left Kurrachee in the steam frigate *Berenice* for Bushire, accompanied by Lieut. Champain, of his own corps. The two marched from Bushire to Teheran, whence Stewart proceeded to England, to arrange for the carrying out of the now clearly-shaped design. Later in the year, Lieutenant Champain undertook the inspection of the country from Teheran to Baghdad. It was arranged that the manufacture of a suitable cable, to be laid from Kurrachee to Bushire, and onwards to Fâo, should be set in hand at once under Colonel Stewart's immediate supervision in London. The line from Fâo to Baghdad, which the Turkish officials were powerless to construct (owing to the hostility of the

Arabs), was to be made by Englishmen; mostly non-commissioned officers of Royal Engineers, selected at Chatham for this duty, working under Col. Kemball and Mr. Greener. Sir Henry Rawlinson's suggestion that a land line should be opened from Baghdad to Teheran, and thence to Bushire, to provide an alternative to the precarious Baghdad-Fâo link, was approved, and negotiations with this aim were entered into with the Shah's Government. At the same time, most careful investigations and soundings of the Persian Gulf were carried on by Lieutenant Stiffe, an officer of the Indian navy, renowned for his skill as a marine surveyor, who from that day to this has rendered invaluable service as engineer and electrician to the Persian Gulf Telegraphs. To supsupplement the Kurrachee-Gwadur section of the cable, a land line along the Mekran coast was commenced, under very difficult and trying conditions, by Mr. Hubert Izaak Walton, an officer of great ability and energy, deputed for the work by the Indian Telegraph Department.

The history of the Indo-European telegraph has been written in minute detail by Colonel Stewart's successor, Colonel (now Sir) Frederick Goldsmid, in his book, "Telegraph and Travel;" and I will give only an outline of the more important circumstances.* The cable from Karāchi to Fâo measured 1,250 miles by the route originally followed, and was made in accordance with the advice and under the electrical superintendence of those eminent engineers, Sir Charles Bright and Mr. Latimer Clark. The conducting wire of the cable was of peculiar form, being composed of four segmental pieces of copper, of a high standard of conductivity, passed through a hollow cylinder of the same metal, and the whole drawn out under pressure so as to form a solid wire, possessing the advantages of the usual strand conductor, but with condensed bulk, and the small surface of a simple wire. This conductor was then most carefully covered by the Gutta-percha Company with four coats of gutta-percha and the same number of layers of Chatterton's compound; on this came a serving of hemp, then twelve No. 7 iron guard wires, then more hemp, and, outside all, two coatings of Messrs. Bright and Clark's asphalt tar and silica mixture. The cable was continually watched and tested with elaborate care by the assistants of Messrs. Bright and Clark at Mr. Henley's works at North Woolwich. When finished, it measured about $1\frac{1}{4}$ inches in diameter, weighed about four tons to the mile, and cost as nearly as possible £200 per mile. It was pronounced at the time to be the cheapest, strongest, and most perfect cable ever made. Colonel Stewart boldly decided to lay it from sailing vessels towed by steamers, a method not previously tried, but which was adopted, owing to the special conditions of the case. The experiment succeeded perfectly.

Five first-class sailing vessels were selected, and fitted with cylindrical iron tanks, into which the cable, as made, was coiled direct from Mr. Henley's manufactory. These ships were the *Marian Moore*, the *Kirkham*, the *Tweed*, the *Assaye*, and the *Cospatrick*, while a small portion of the cable was sent out in the little steamer *Amberwitch*, which had been purchased and fitted for permanent use as a repairing ship in the Gulf. I may here remark that the *Amberwitch*, from that day to this, has (under the able command of Lieut. Stiffe) performed constant and admirable work in connection with the Persian Gulf lines, besides a considerable amount of service for other departments under the Government of India. The steamers provided by the Indian Government to tow the sailing vessels which brought out the cable were ships of the old Indian navy, the *Coromandel*, the *Zenobia*, the *Victoria*, the *Semiramis*, &c. The laying of the line was begun early in February, 1864, and on the 8th April the Faô station, at the mouth of the Shat-el-Arab, was in direct telegraphic communication with Kurrachee.

While this important work was being so successfully accomplished, under the immediate eye of Col. Patrick Stewart, Mr. Walton was, as before mentioned, pushing on the Mekran coast land line. Mr. Greener and his assistants, under Col. Kemball's superintendence, were completing the link across the Arab country, between Baghdad and Faô, and Lieut. Champain and his staff* of three other engineer officers, 12 non-commissioned officers of the same corps, and several civilians, were busy on the line from Baghdad to Teheran, and from Teheran to Bushire (the alternative to the Baghdad-Bushire direct section). The country traversed presented many physical difficulties, and was then, of course, very much less known than at present. The Persian officials were, in many cases, inclined to thwart and oppose the efforts of the English telegraphists, while the lower classes were troublesome and suspicious. The work, however, which was begun in the late autumn of 1863, was finished by the 13th October, 1864. The distances, in round numbers, being—

Bagdad to Teheran	500 miles.
Teheran to Bushire	800 ,,
Total	1,300 ,,

The actual construction of the first lines connecting Europe and India was completed on the 26th January, 1865, although (to use Colonel Goldsmid's words), "No decisive success was achieved wherewith to signalise the fact. Messages passed, it is true, between India and England, but irregularly and slowly. Hitches would occur somewhere, and the line was too long, and the working of too novel and promiscuous a character for speedy repairs and corrections. In fine the opening communication was comparatively lame and unattended with *éclat*, and the science and energy which were available to make light of physical hindrance were sorely taxed in dealing with national jealousies and the caprice of individuals."

From July, 1864, Colonel Stewart was at Constantinople, latterly suffering seriously in health, but vigorous as ever in his efforts to induce the Ottoman authorities to take the necessary steps for securing efficiency in the new line. In December he was attacked by a pernicious intermittent fever followed by a complication of disorders. The strain

* The following sketch of the Indo-European telegraph to India is mainly taken from S Frederick Goldsmid's full and graphic report.

* Lieut. R. M. Smith, R.E., Lieut. O. B. St. John, R.E., Lieut. W. H. Pierson, R.E., Mr. Man, C.E., and Mr. Henry V. Walton, C.E.

upon his powers, both mental and physical, had been too great, and it was fated that he should die at the early age of thirty-two years, not on the field of battle, but on one not wanting in glory. He breathed his last on the morning of the 16th January, 1865, and was buried by the graves of our Crimean heroes in the beautiful English cemetery at Scutari. I may add that, in lasting token of respect and love, no less than three memorials have been raised to Patrick Stewart since his death.

Thus it may be said that telegraphic communition between England and India was for the first time an actual fact in the beginning of 1865; and with this circumstance and the melancholy death of Colonel Stewart an important chapter of this history closes.

Colonel Goldsmid was selected as the new Director in Chief of the Indo-European Department, and it fell to the lot of that able and indefatigable officer to organise the working of the through line, which I have just shown had been very far from satisfactory. The irregularities and delays, not only in Turkey, but between London and Constantinople, were most vexatious and disappointing.

Mr. L. W. Courtenay, the zealous and experienced officer, who, with the title of "Commissioner for the Indo-European Government telegraph," was settled in Pera for purposes of international account and general reference, was most persevering in his efforts to bring things into order, but met with little success; while in another direction the breaks in Persia, mainly owing to wilful damage unchecked by the Shah's officers, were dishearteningly frequent. Col. Goldsmid left England in June, 1865, for Teheran, to negotiate a new and more comprehensive treaty with the Persian Government, while Major Champain (who had been appointed as Col. Goldsmid's assistant, and had made over charge of the work in Persia to Major Murdoch Smith, R.E.) returned for a short time to England to carry on the duties of the London office during the absence of his chief. Notwithstanding all drawbacks, traffic was springing up. In March, 1865, the first month of *bonâ-fide* working, 1,447 messages were exchanged between Europe and India. In April, 2,160 were sent. The speed of transmission varied from four or five hours to eight or nine days, and occasionally even more.

After much tedious labour at Teheran, Col. Goldsmid managed to arrange an agreement providing for a second wire on the posts between Bagdad, Teheran, and Bushire, this wire to be exclusively devoted to international traffic, and steps were at once taken to provide and send out the required material.

Months passed, and little or no improvement was apparent in the through working. Now and again messages were flashed from end to end at creditable speed, while others were days and even weeks on the road. In February, 1866, Major Champain was deputed to Constantinople to inquire into and report on the condition and prospects of the Turkish line, and he took the opportunity to point out very clearly to Agathon Effendi, the head of the Ottoman telegraphs, that Anglo-Indian interests required and would have a trustworthy and regular line of telegraph; and if that could not be obtained *viâ* Turkey, it would most certainly be provided elsewhere. Complaints were far too serious to be overlooked or lightly regarded, and already the mercantile community was pressing on the Government the necessity of the adoption of new measures. The Indian Government cables through the Persian Gulf were all the time in excellent order, and admirably worked under Mr. Walton's energetic supervision, while the completeness and efficiency of the traffic arrangements reflected high credit on Mr. Alfred Brasher, the zealous manager of that intricate branch of the administration. The Persian lines were precarious, but their working being in English hands, it was felt that improvement might fairly be hoped for, and it was known that no expense or pains would be spared in supplying the best material and the best *personnel*, and in profiting by experience of what was really defective.

The prospects of the Turkish lines were less hopeful; and the European wires between London and Constantinople were scarcely more effective than those across Asiatic Turkey to Fâo. The number of small administrations traversed, each receiving but a small proportion of the tariff, and comparatively little interested in the success of the enterprise, was an obstacle in the way of amelioration. The old adage of "Too many cooks" applies as much to telegraphy as to anything else; and the attention of all concerned was now directed to the discovery of some near route to the Persian Gulf, where inherent defects such as those of the Turkish line might be avoided. There appeared to be no possibility of Englishmen obtaining the control of a wire from London to Constantinople, nor across from that capital to the Persian Gulf; but it seemed probable that something might be done by way of Russia and the north of Europe. The apex of the Persian telegraph triangle was Teheran, and this capital is distant from the Russian Caucasian frontier at Julfa, on the Arax, only 500 miles. A wire had already been carried by the Persian Government across this stretch of country; and communication, not, however, of a very effective kind, was already established between Europe and Persia, viâ Tiflis. The idea of utilising the northern route was first entertained in 1865, and, before long, was forced into prominence by the enterprising efforts of the celebrated firm of Siemens and Co. These gentlemen had previously organised the whole Russian system of telegraphs. Their connections in Russia and throughout North Germany gave them exceptional advantages in undertaking such a scheme as that now contemplated, and early in 1867, Mr. William Siemens submitted to the Indian Government a thoroughly prepared project for working a special telegraph between London and Teheran. The Prussian and Russian departments were by no means indisposed to support a plan which promised, if well carried out, to attract to the Northern lines a large share of the Indian traffic; and Colonel V. Chauvin, the Director-General at Berlin, was one of the warmest promoters of the Siemens scheme. To make a long story short, the European concessions required were obtained during the year 1867, that from the Shah of Persia in January, 1868, and the Messrs. Siemens found themselves at liberty to organise and work two wires specially devoted to

Indian traffic over the whole distance from London to Teheran, The Persian section had to be made entirely afresh.

To carry out the Siemens arrangement, and to give full effect to the valuable privileges obtained, a company was at once established which adopted the now well-known title of "The Indo-European Telegraph Company, Limited." The name was perhaps somewhat misleading. The words Indo-European Telegraph had from the first been used to designate the original line to England *viâ* the Persian Gulf and Turkey, although perhaps in strictness they only applied to the Persian Gulf cables and those portions of the system which were made and worked by the Indian Government officials. Be this as it may, the designation Indo-European Company's lines now signifies those special wires between London and Teheran, *viâ* Lowestoft and Emden, Berlin, Warsaw, Odessa, Kertch, Tiflis, and Tabreez, while the Government Indo-European Telegraph Department embraces the lines in Persia, south of Teheran, the Gulf cables, and the Mekran coast land line.

The Siemens proposal having now assumed a definite and promising aspect, and the work of organisation and adaptation having been set in hand by the new company (one of whose most prominent members was its present very efficient manager, Mr. W. Andrews), the attention of the Indian Government was turned to the development and improvement of its Gulf system, so as to prepare it to carry on its part of the expected work.

A single wire from Bushire to India was pronounced insufficient; and it was determined to lay a second cable from Jashk, the Mekran coast line being extended from Gwadur to Jashk. A third wire was to be attached to the Teheran-Bushire section, so that one wire might be set aside for local Persian requirements, while two could be devoted entirely to the international business. Gradually, too, the posts, originally of wood (poplar, chenar, and mountain oak) were to be replaced over the entire 800 miles by more permanent and less easily damaged iron standards.

In June, 1868, British India, for the first time, was represented at the periodical telegraph conference of the European States, held on that occasion at Vienna. The Indian representatives were Colonel Goldsmid and Colonel Glover, and some important regulations, specially affecting the Indian tariffs and traffic, were inserted in the revised convention.

Early in the year 1868, Col. Goldsmid had, after long consultation with Mr. Latimer Clark and Lieut. Stiffe, decided on advising the Government to use an india-rubber covered cable for the new length to be laid between Jashk and Bushire. A specimen piece of Mr. Hooper's material had been submerged, for the sake of experiment, in the Persian Gulf, near Bushire, in 1864, and had been the only one, among several cores so tried, which had, after years of exposure, shown no signs of deterioration. It was believed that in warm climates, especially for such parts of the cable as the shore ends—which are alternately exposed to wet and dry heat—india-rubber would possess advantages over the usual gutta-percha. I cannot, however, here enter into all the reasons urged for the employment in this case of Mr. Hooper's india-rubber core, though I may observe that now (nearly 10 years after its manufacture) the second Persian Gulf cable remains in excellent condition, and shows no symptoms of decay. Excepting for the difference in the core, the new cable was precisely like the old one, and was made and tested under the supervision of Mr. Latimer Clark and his able scientific assistants, Messrs. F. Webb, Herbert Taylor, &c. It was arranged, as in the case of the original cable, to lay the new 500 miles out of sailing vessels, in tow of steamers. The Suez Canal not being in existence, the expense of transport in steamers round the Cape would have been very considerable. Two magnificent sailing ships were chartered to take the cable out; the *Tweed*, which had been engaged in the first expedition, and the *Calcutta*, a fine iron vessel belonging to Messrs. Mackay and Son. The operations in connection with the second Gulf cable were delayed by several serious and unavoidable *contretemps*. The *Calcutta* left England with her valuable cargo on an unlucky Friday, the 29th of January, 1869. She carried 273 miles of cable in three watertight iron tanks. On the 9th of February, she came into collision with a Russian barque off the Lizard. The smaller vessel sunk immediately, four only of her crew of eleven men being saved. The *Calcutta* appeared in such imminent danger of also going down, that Captain Owen, after first throwing out all the cables in the fore tank (some 70 miles) decided to abandon the ship and endeavour to escape in boats to the neighbouring coast of Cornwall. Unhappily, Captain Owen and thirty of the crew were drowned on leaving the *Calcutta*. The rest, some 33 in number, reached the shore, and at once telegraphed the disastrous news to London. The Admiralty authorities, on being informed of the accident, promptly despatched the *Terrible* from Plymouth to seek for, and if possible, bring in the derelict vessel, and by the Wednesday she was moored in her crippled state under shelter of Plymouth breakwater. Subsequently, Mr. F. C. Webb, C.E., one of the most energetic and practical officers of Mr. Latimer Clark's staff, who had formerly served the Indian Government in the Persian Gulf, was placed in charge of the repairing operations. He succeeded most skilfully in recovering the 70 miles of cable which had been thrown overboard in the Channel, and, after infinite anxiety and labour, the *Calcutta* and *Tweed* sailed at last on the 27th and 30th of June.

The officers who were to direct the operations in the Gulf, left England by the overland route early in September, so as to meet the two cable vessels in Bombay. Their journey out was singularly unlucky. On the 17th September, Colonel Goldsmid, in London, received the following telegram from Suez:—"*Carnatic* utterly wrecked, all telegraph party saved, all mails and baggage lost." Twenty-eight of those on board were drowned on this occasion. Mr. Latimer Clark sustained serious injuries, and all the valuable instruments and papers relating to the expedition which happened to be on board the ill-fated ship were lost. The operations were not, however, delayed more than a week by the lamentable incident, and on the 1st October the staff reached Bombay, where the *Tweed* and *Calcutta* had arrived just ten days before.

The *Dacca*, a fine steamer of the British India

Steam Navigation Company, and the *Earl Canning*, a Government vessel, were in readiness for the towing work; the little *Amberwitch* rendering constant assistance. By the 6th November everything was completed, and Bushire in full communication with Jashk by the new india-rubber cable (502 miles in length) as well as by the old gutta-percha cable.

The extension of the Mekran land lines from Gwadur to Jashk, had, meanwhile, been most ably carried out under Mr. Hubert Walton and his assistants, Messrs. Douglas Walker and others, who received on every occasion the most hearty support and encouragement from Sir William Merewether, Commissioner of Sind, as well as from Major Ross, the political officer stationed on the Mekran coast, and other officers in similar positions. The construction of these lines called for powers of organisation and physical labour and endurance of no common kind. The difficulties presented by the precipitous and almost inaccessible character of parts of the coast were excessive; and the hardships arising from the nature of the climate and from want of water were exceedingly trying to all engaged. Opposition on the part of the scanty inhabitants of the country was not, however, one of the obstacles to be encountered, owing to the successful protective arrangements made by Col. Goldsmid with the native chiefs, who for a small annual payment cheerfully co-operate in protecting this part of the Indo-European line. Thus, at the end of 1869, affairs stood thus, the originally planned Turkish land line was the only one actually in operation. It consisted of eight routes from London, converging on Constantinople, a double land line to Fâo, a cable thence to Bushire, with an alternative land line from Baghdad *viâ* Teheran to Bushire, and a double chain from that port to India, viz., two cables to Jashk, completed by a cable and land-line onwards to Kurrachee. The working of the line, though somewhat improved during the previous two or three years, was anything but faultless, and complaints of its irregularities were rife in all quarters. The Indo-European Company's line to Teheran was being rapidly pushed on, and another most important rival, to which I must now direct attention, was being carried out with striking success.

It is not my intention to follow very closely the various steps which have, in the course of many years, led to the completion and perfection of the remarkable system of telegraphs known as that of the Eastern Telegraph Company. An interesting account of the laying of the Suez-Aden-Bombay cable was written by Mr. J. C. Parkinson in 1870, and published by Messrs. Blackwood, under the title of "The Ocean Telegraph to India." I have taken the liberty of borrowing from Mr. Parkinson's work many of the details and facts which follow.

At the time when the Indo-European line of telegraph was designed and carried out, belief in submarine telegraphy, on an extended scale, had been very sorely shaken. The failure in the Atlantic, and the utter collapse of the guaranteed Red Sea cable, were events of too recent a date to have been forgotten by the British speculator and capitalist. Moreover, there was little trustworthy information as to the durability of submarine lines. The cost of making and laying a cable was a simple matter of estimate, and known to be heavy; but the risks that cable might run from hidden dangers during and after submersion were matters of conjecture and doubt; and the possibility of raising and repairing (should such an operation be necessary in deep water) was disputed. There were, however, in this country, a few enterprising, determined men, quite unwilling to acquiesce in the impracticability of laying a cable by the Red Sea route to India, provided only that no precautions which science and care could devise were omitted in its manufacture and submergence, and provided, of course, that the large sum of money required could be raised. The directors of the Construction and Maintenance Company, who had acquired the telegraph works of Messrs. Glass, Elliot, and Co., and the old-established gutta-percha works of Messrs. Ford, Barclay and Co., had in 1861 successfully laid the new cable between Malta and Alexandria, and had bought up the Government interest in the old one. They had made the telegraph from Malta by sea to Sicily, and a direct line through Italy to the French frontier at Susa; and were persistent in their resolution, somehow or other, to complete the system, *viâ* Egypt, to India, and so establish submarine communication between the Continent of America, through the Atlantic cables, to the distant shores of India. But the public hung back from subscribing the funds wanted, and for a long time it seemed inevitable that, unless another Government guarantee could be secured, the project would fall through for lack of the "sinews of war." Time after time application was made for State support, but without success. In July, 1867, Captain Sherard Osborn wrote to the Secretary to the Treasury, stating that the Anglo-Indian Telegraph Company were prepared to lay a cable to India if a capital of one million could be raised; and application was made for assistance in the preliminary marine survey. The money, however, was not forthcoming, and the project was once more temporarily abandoned. In August, 1867, Mr. Charles Stewart, chairman of the Anglo-American, as well as of the Anglo-Indian Telegraph Companies, submitted a letter to the India-office, which may be epitomised as follows:—Mr. Stewart proposed to take over from the Indian Government the Persian Gulf cable, guaranteeing to keep it in repair, and paying five per cent. on its cost for its use. Mr. Stewart, on behalf of his company, promised to relieve the Treasury and the Indian Government of the annual payment of £36,000 a year on the old Red Sea failure, mentioned at the beginning of this paper, and, in order to enable the company to raise the million wanted, he solicited an Indian Government guarantee of five per cent.

The Secretary of State for India declined to accede to Mr. Stewart's request, observing that there were strong reasons why the working of the Persian Gulf cable should be retained in the hands of the Indian Government. Other correspondence of a similar character followed, until at last the promoters of the cable to India boldly resolved to subscribe the bulk of the capital among themselves, and wait no longer in the hope of financial help from the Government.

The new company was styled the British-Indian Submarine Telegraph Company, and, even before its prospectus was published, nearly £400,000 were promised by about a dozen individuals.

Messrs. John Pender, Cyrus Field, Glass, J, R. Maclean, Sir James Anderson, Mr. George Elliot, Sir Daniel Gooch, and the Messrs. Brassey were prominent among the sanguine promoters of the undertaking. Mr. Pender, the first on the above list, had been chairman of the Telegraph Construction Company, but retired from that board in order to devote all his energies to the promotion of the cable to India. The Telegraph Construction and Maintenance Company, whose managing director was the late Captain (afterwards Admiral) Sherard Osborn, contracted to lay the cable for £1,000,000, and to take no less than £460,000 of that sum in paid-up shares of the British-India Company. The contract was made in January, 1869, and the Construction Company bound themselves to complete the line from Suez to Bombay by April, 1870.

The engineers to the company were Mr. Latimer Clark and Mr. H. C. Forde. The cable differed in no very essential points from the first one laid in the Persian Gulf, and described above. Its conductor was a strand of seven copper wires, instead of a quasi-solid single wire, as in the Gulf. Over the conductor came the several coats of gutta-percha and Chatterton's compound, then the jute or hemp, the iron guard wires, and, finally, outside all, the patent silica and pitch compound invented by Messrs. Bright and Clark. The entire length to be submerged between Suez and Bombay was was 3278 nautical miles, *i.e.*:

Between Suez and Aden	1,460 miles
„ Aden and Bombay	1,818 „
Total..............	3,278

The promoters of this grand enterprise were fortunate in having at their disposal that magnificent and propitiously named ship, the *Great Eastern*, a vessel so admirably adapted for the work that her special mission would almost seem to be the laying of deep sea telegraphs. She carried no less than 2,375 nautical miles of cable in her tanks, while her companion ships, the steamers *Hibernia*, *Chiltern*, *William Cory*, and *Hawk*, were laden with 1,225 miles more, making a grand total of 3,600 nautical miles. The *Great Eastern*, under Captain Halpin's command, left England on the 6th November, 1869, bound for Bombay by the Cape of Good Hope. She arrived at her destination on the 27th January, 1870, shortly followed by the *Chiltern*. The Bombay shore end was laid on the 7th February, and on the 14th the *Great Eastern* began the lying of the Bombay-Aden section. The arrival of the British India Cable Expedition at Bombay was cordially welcomed by the governor, Sir Seymour Fitzgerald, and by the community at large. A flattering message of congratulation was telegraphed across India by Lord Mayo, and no enterprise could have been inaugurated under brighter auspices. The merchants of India had for long been thoroughly disappointed by the shortcomings of the Turkish line to Europe, and were not altogether prepared to believe in the improvement promised by the Indo-European Company; on the other hand, the confidence in their own scheme shown by the British Indian cable promoters, the accounts of the care and trouble taken in the manufacture and shipment of the enormous cable, and the circumstance of Bombay itself having been selected as the Indian landing place, all tended to enlist the local sympathies in favour of the new line. I may remark, in passing, that some not unfriendly controversy had been carried on for some time between the advocates of the Teheran line on the one hand, and those of the Red Sea on the other. The former insisted that although by the light of lately gained experience the cable might possibly be laid with primary success, it would run terrible risks from coral reefs and other hidden enemies, while should a break once occur the chances of being able to pick up and repair would be slight. They maintained that interruptions to the Persian Gulf cable which lies in comparatively shallow water, viz., from 40 to 60 fathoms, would be of little importance; several had already occurred, and all had been set right with ease and with little loss of time. Accidents to the land lines in Persia and the Caucasus might at first be frequent; but with a well organised system of line guards no interruption should continue more than a few hours.

The Red Sea cable supporters were, of course, quite as strongly convinced of the advantages of their route, and of the inherent fatal weaknesses of the other. They declined to admit the probability of accidents to their cable when once submerged; they were satisfied that care in selecting the course of the laying vessels would avoid danger from reefs; and they laughed at the idea that the land line officials in Persia and Russia could keep the Indo-European line in decent order at all. I think that, after eight years' experience, both sets of disputants will allow, and allow gladly, that each was right and each was wrong. Right in the hopeful view taken of their own plans, wrong in the disparaging opinions expressed as regards their rivals. Both routes have succeeded admirably. They have been honestly worked in a fair and far from hostile spirit of competition, and the two combined have afforded a sound, solid, and much-needed system of telegraphic communication between Europe and Asia. For my part, I look upon the telegraphic system brought into existence by the several companies now associated under the title of the Eastern Telegraph Company, as worthy to rank among the grandest achievements of private enterprise of any county or of any age.

On the 27th February, the *Great Eastern* had laid her cable between Bombay and Aden, no hitch or accident of any sort having occurred. On the 5th March, Mr. Forde (the electrical chief), after several days' careful testing, certified to the technical perfection of the section, and, on the following day, Captain Halpin recommenced operations in the direction of the Red Sea. The *Hibernia* and *Chiltern* were in close attendance, the latter working on the shore end and main cable splice. On the 8th March the *Great Eastern* stock of cable was all paid out, and the *Hibernia* took her place. The remainder of the paying out up the Red Sea was successfully effected from the *Chiltern* and the *William Cory* steamers, and on the 22nd March the Bombay, Aden, and Suez cable was ready for work.

The preliminary arrangements seem to have been excellently conceived and carried out by that eminent officer, the late Captain Sherard Osborn, on behalf of the Construction Company, and by Sir

James Anderson, the managing director of the British-Indian. The actual execution of the operation was conducted by Captain Halpin, and a large share of the credit for the triumphant results attained is due to those three experienced commanders. On the 26th March, 1870, the British-Indian telegraph was opened to the public.

The British-Indian messages for the East were, at this period, transmitted to Malta, either *viâ* Italy or *viâ* France; but before the laying of the Red Sea cable, a company had been organised under the title of the Falmouth, Gibraltar, and Malta Telegraph Company, to complete the submarine communication between England and Egypt, thus rendering the entire system independent of the Continental administrations. This work was accomplished by the month of June, 1870. In 1872, the several* companies owning lines of cable between Falmouth and Bombay were amalgamated, and are now known as the Eastern Company, Limited, the chairman being Mr. John Pender, M.P., and the managing director, Sir James Anderson.

Although, as I have stated, the dismal forebodings of the respective advocates of the cables and of the land lines, as to the inevitable discomfiture of their opponents, have certainly not been verified, yet experience has proved the truth of what might have been naturally assumed, and the land lines have suffered from many interruptions of short duration, while the Eastern Company's cables have given way but seldom, but then the breaks were comparatively very serious. The breaks on the Indo-European Company's wires and on the Persian section have been too numerous to recapitulate; but, until the Russo-Turkish war, when part of the line near Sukhoum Kaleh was† completely destroyed, no really disastrous interruption to the traffic has occurred. On the other hand, the Red Sea cable was paralysed for 15 days in 1870-71, and the Lisbon-Gibraltar cable for 72 days; the latter accident being of less consequence, thanks to the land line across Europe. In 1874-75 the Falmouth-Gibraltar cable was broken for 33 days, and in 1875-76 the Red Sea line was again interrupted for no less than 80 days, during which time the Eastern system (so far as its Indian traffic was concerned) was, of course, thrown out of work. This last mishap roused the directors of the Eastern Company to carry into effect, without further delay, their long-cherished intention of duplicating the Suez-Bombay submarine line.

As on the former occasion, the manufacture and submergence were undertaken by the Telegraph Construction and Maintenance Company, the managing director being Admiral Sir George Richards, F.R.S.; Messrs. Clark, Forde, and Co. were the engineers. The cable resembled the first one, except that the gutta-percha was of still more perfect quality. The steamers employed were the *Kangaroo*, the *Hibernia*, and the *Seine*, and the expedition was again under the supreme control of Capt. Halpin, assisted by Mr. London. The vessels passed through the Suez Canal, and the paying out of the cable down the Red Sea was begun on the 27th October, 1876, and finished as far as Aden by the 11th November, the total length of the Suez-Aden section being 1,443 knots.

On the 23rd February, 1877, the *Hibernia* commenced paying out from Aden to Bombay, where the final splice was made, and the second cable completed by the 7th March. The Aden-Bombay section measuring 1,889 knots in length.

Thus, since the beginning of last year, the Eastern Company has been in possession of a very strong and complete doubled system of communication with the East, and the lines to India may now be enumerated as follows:—

1. The Constantinople route to Fâo, and single cable to Bushire.

2. The distinct double line from London *via* Teheran to Bushire; a gutta-percha cable from Bushire to Kurrachee; a cable (Hooper's core) Bushire to Jashk; a double land line, Jashk to Kurrachee.

3. A cable from Falmouth, *via* Gibraltar and Malta, to Suez; land lines across France and Italy to Malta and Suez; and two cables from Suez to Bombay.

The public are at liberty to direct their messages by either of the above routes, heading their messages by the words, *via* Turkey, *via* Indo, or *via* Suez, no charge being made for this indication.

When the Indo-European lines were first completed in the winter of 1864-65, the European standard for the measurement of messages was naturally adopted; that is to say, the minimum charge levied was for a despatch 20 words long, all addresses and signatures being counted and taxed; an extra half rate was charged for messages over 20 and up to 30 words in length. The tariff on the first 20 words was fixed at £5, with a £2 10s. charge on every additional 10 words. The rate, no doubt, appears high, but it must be remembered that the cost of laying and maintaining long submarine cables, and extra European land lines, is very great; and the conditions of Indian business did not seem to promise that extraordinary elasticity of traffic which might fairly be looked for on the cables to America.

The large mercantile houses in India likely to make constant use of the wires, are, comparatively speaking, few in number, and to fix a charge low enough to induce private individuals to employ the line, to any remunerative extent, seemed impracticable.

The capacity of a single submarine conductor is limited, although many inventions and improvements, introduced since the time of which I speak, have enormously increased its power. In transmitting a message over a line of telegraph, a large number of words and figures, such as the number of the message, date, official instructions, the name of the sending station, repetition of doubtful words and figures, &c., are not charged for; so that on the average some 30 words are signalled in sending a message paid for as one of 20 words. This 20-word standard and £5 charge were in force during the first few years' working, viz., from 1865 until 1868, and it is certain that, partly owing to the high rate, and partly owing to the bad working *via* Turkey, the traffic showed no signs of growth. 39,000 messages were transmitted over the wires in 1865-66, and only 40,000 in 1868-69.

* The Anglo-Mediterranean established 1868; the British Indian sumbmarine, 1866; the Falmouth, Gibraltar and Malta, 1869; Marseilles, Algiers, Malta, and Levant Telegraph Company, 1870.

† The Indo-European Company took prompt steps to bring into working order a fresh wire, further from the Black Sea, and out of reach of the Turkish invaders.

On the 1st January, 1869, in consequence of representations made by the Continental telegraph administrations to the Indian delegates at the Vienna Conference, the 20-word charge was brought down from £5 to £2 17s. The experiment was, however, unsuccessful, and the failure proved that the untrustworthy character of the working operated more strongly than the high charges against growth of business. In short, although the number of messages did somewhat increase, viz., from 40,000 to 52,000, the receipts on the Persian Gulf cable alone fell off by £20,000 a year. The Indo-European Company's line and the British-India Submarine, who had been counting on the £5 charge being maintained, were obliged to accept the reduced rate, and soon after they commenced operations, in 1870, it became manifest that the three lines between Europe and India could not be kept going on the £2 17s. tariff. The Turkish lines, supported by imperial funds, might survive the struggle for existence, but the two companies' systems, established by immense efforts and outlay, and which promised first-rate lines of communication, were threatened with immediate ruin.

The question to be decided was this—Are we to revert to the old plan of depending on one bad, but comparatively cheap, telegraph, *via* Turkey; or are we to adopt protective measures, in order to escape from a monopoly which has been so long tried and so unanimously condemned? There was little hesitation as to what course should be followed, and in 1871 a special meeting of European telegraph officials was held at Berne, and the £2 17s. rate raised to one of £4 10s. Since then the charge to India has remained at about that rate, but the message standard has been materially altered, and, in my opinion, with very great advantage.

On short inexpensive lines, a 20-word minimum is all very well, but on long extra-European chains of communication, where the charge even for a few minutes' use of the line must be heavy, a smaller measure seems from every point of view desirable.

The delegates of the Indian Government, who have attended the periodical international telegraph conferences since India's first adhesion in 1868, first at Vienna, then at Berne, Rome, and St. Petersburg, deserve the credit of having led the way in this and other similar reforms. And here it would be unpardonable of me to omit to mention the name of Mr. Alfred Brasher, the superintendent of the Government Indo-European London office. Mr. Brasher has been in the department since its origin, and has done perhaps as much as any single individual to reform and systematise the traffic and account arrangements of these long extra European chains of telegraph. The first step was to reduce the 20-word message to one of 10 words, then to adopt a word increment. This having been permitted, and proving satisfactory in practice, the Indian delegates, with the approval of the several submarine companies interested in the matter, obtained leave at St. Petersburg in 1875, to introduce, on extra-European lines, a single word standard with a proportionately reduced tax. The charge now to India is 4s. 6d. a word *via* Teheran or *via* Suez, and 4s. *via* Turkey, and such a message as the following, "Smith, Calcutta, arrived," would cost but three times 4s. 6d. or 18s. 6d. by the two first named routes, or 12s. by Constantinople. We have also reduced the length of a word from the original extravagant seven syllables to 10 characters. Figures, which are more than twice as troublesome as letters to transmit, are rated at five to the word.

I have just shown that, during the period when the Turkish line was alone in the field, the annual amount of traffic (reduced to messages of 20 words in length) did not exceed some 40,000 or 50,000. But directly the Russian and Red Sea routes came into play, and passed the telegrams from end to end of the line in a few hours instead of days, the traffic, notwithstanding the increase of the tariff (to nearly its original figure) began to develop with great rapidity. In 1871-72 the number of messages between Europe and India rose to 77,000, while in 1877 they amounted to 132,000. Of this number but a small proportion passed *via* Turkey because of the comparative inferiority of the working by that route. The bulk of the Indian traffic was pretty fairly divided between the Teheran and the Eastern administrations.

The development of telegraphic communication east of India, Australia, China, &c., by the enterprising efforts of private companies closely connected with the Eastern, has no doubt largely contributed to the augmentation of the business over the lines to India. But leaving the trans-Indian traffic out of the question, the number of purely Indian messages has more than doubled since the opening of the companies' lines.

The speed attained over the lines to India is very great. No efforts have been spared by Major Smith in Persia, by Mr. Ffinch (Mr. Walton's successor), by Mr. Andrews on behalf of the Indo-European Company, nor by Sir James Anderson for the rival route, to work the messages with rapidity, regularity, and accuracy, and the results appear to be eminently creditable to the several administrations. Considering the puzzling nature of many of the mercantile codes in use, and the many contingencies to which a complex machine like the telegraph to India is exposed, it may be said that complaints of any kind are now surprisingly rare. The pace for years past has been under three hours between London and Bombay or Calcutta. To thoroughly realise what this means, one should perform the journey, as I have repeatedly done, by rail from Calcutta to Bombay, by sea to Bushire, then slowly and tediously on horseback over mountain passes and sandy plains, 1,300 miles to Julfa, thence by carriage to Tiflis and Poti. From Poti to Odessa by steamer, and across Europe by rail. The messages frequently take fewer minutes than the traveller takes months to traverse this stretch of 7,600 miles. The most difficult portion of the whole to keep in order is certainly that from Bushire to Teheran, but, thanks to the admirable management of Major Murdoch Smith, R.E., and his staff, interruptions of serious duration are now scarcely known. Unluckily, every peasant in Southern Persia carries a gun, and delights in practising on our posts and insulators as marks. Major Smith has now established small testing stations every 40 or 50 miles, and breaks are discovered and repaired with remarkable celerity.

The Government telegraphs in India, under the direction of the late Colonel D. G. Robinson, R.E., have been, during the last 10 or 12 years, almost entirely reorganised, and are now second in solidity and efficiency to no lines in the world. Colonel Robinson's reputation as an energetic and talented telegraph administrator stands high. His labours at the head of the Indian telegraph department were crowned with success, and earned him the hearty recognition and praise of the Government he so faithfully served. In everything relating to telegraphy he took the warmest interest, and especially in the lines between India and Europe; and his unexpected death in July, 1877, was widely and deeply deplored.

Colonel Robinson was one of India's representatives at three successive conferences, and his influence on the management, not only of the Indian but of the extra-European telegraphs, was so marked that I need make no apology for here offering this imperfect tribute to the memory of my friend and brother officer.

It will be seen that by the three lines which I have described, telegraphic communication with India is very solidly established. News of every sort, and quotations of the London market of this day, will appear in the Indian journals of to-morrow. Every movement which occurs in the East can be made known here without an hour's delay, and, of course, a very considerable part of the Government work is carried on by means of the wires. The *Times* has a special arrangement, under which a copious telegram is despatched by their Indian correspondent at reduced rates, every Sunday when other telegraph work is slack; and two or three newspapers are about to follow their example. Messages of a domestic character are, comparatively speaking, few in number, owing to the high cost of this means of correspondence.

In conclusion, I venture to add a word or two on the possibility of reduction in the charge. The cost of such long chains of communication is enormous; and here I speak not only of the original outlay, but also of the actual expenses of maintenance and repairs. The risk of injury and of eventual decay, though more remote than was once believed to be the case, is great, and if substantial returns can be obtained by those who have invested their capital in these undertakings no objection can be fairly raised. Whether a line be the property of Government or a private company, it certainly ought to be worked so as to pay. Given a certain amount of traffic, and a single line, the rates may be low, but in that case, the communication is unsound. The principle approved at the international conferences, and followed in practice, is that several distinct lines should, where possible, be provided, but that competition in tariffs should be discouraged.

Practical experience has shown that sensible reduction of charge does not lead to corresponding increase of business. To the large mercantile houses, &c., the telegraph is a necessity; to private individuals it is scarcely more than an expensive luxury. The former would certainly not send four messages at £1, where they now send one message at £4; while the domestic correspondence would not be augmented to any appreciable extent. Telegrams are in fact, cold-blooded and business-like communications, which will never supersede the epistles of private life.

The shilling charged for twenty words in the United Kingdom can scarcely be called a prohibitive tariff. For my part, when I have to send some hasty notice to my friends, I find the wires excessively useful, but I do not confide to them my bosom's secrets, nor should I employ them much oftener than at present if my 20 words cost a penny instead of a shilling. It is a little surprising that officers and others serving in India do not avail themselves more freely of the advantages offered under the present conditions. One word, if registered at the London office, suffices to indicate the address to which a telegram is to be forwarded, and the sender is not now compelled to insert his name in the body of the despatch. With a simple pre-arranged code, three words are enough to convey valuable information, especially when, as is generally the case, the circumstances necessitating the message have been to some extent foreseen.

DISCUSSION.

The Chairman invited Sir James Anderson to address the meeting, and hoped he would direct his attention especially to that part of the question which related to the security of telegraphic communication in the event of war.

Sir James Anderson said that, since 1867, when the noble Chairman and he became associated in telegraphy, they had laid down about 16,000 miles of line between England and India alone; and taking all the lines to China, America, and the Brazils, there were now about 60,000 miles of line connecting this country with the rest of the world. This showed a very important fact, namely, that we had arrived at a period when we had to count with telegraphy, when Governments, armies, fleets, and commercial men must use the telegraph or fall behind. Major Champain had told them of a proposition which the telegraph convention formulated from the commencement; in a very few words, that one of its main objects should be to create as many wires as possible for telegraphing without creating any ruinous competition. They had carried this out, and it had proved a greater principle than was contemplated at the time, for there was now this peculiarity, that in every part of the civilised world you could telegraph from any one State to every other, and, except in the Persian Gulf, private enterprise alone had created the possibility of every State in the world telegraphing to every other part of the world. And the convention had done more. You could go into any office anywhere, and on paying the prescribed sum, and writing the message, it would go wherever you chose. You had nothing to do with seeing it done accurately, or with the adjustment of the sum you had paid between the different companies. These things were as important as any international conference had ever attained in this world. Many people might not think about that convention much, and others looked at it as something designed to keep up tariffs, but in fact without that conference telegraphy round the world would be an impossibility. The question of war, which no one could help thinking about, made a person engaged in the profession of telegraphy wonder what would happen if the lines were cut, and what the enemy would do if war should break out. To his mind it became the duty of a Government likely to be involved in war to study this question very carefully, and to prepare, if possible, some pre-arranged plan by which it could communicate within a given time with this country or with the seat of Government. He

had it in view that, although we had lines to Egypt, for example, by way of Falmouth to Portugal, Gibraltar, and Malta, another through Marseilles to Algiers and on to Egypt, another by way of Italy, and another by way of Athens, all these might be cut by an enterprising enemy, and the only method he could think of, of establishing neutrality for cables in time of war, was to create so many lines of communication by land and sea that the enemy would not think it worth while to cut any of them, because there would still remain some which could not be interrupted. That, perhaps, as far as Europe was concerned, was already established, so that if all the main lines of cable were cut, not more than three dispatch boats would be necessary between the fleet at Malta, in order to keep up communication within 48 hours with this country. That was an important matter, which had all been brought about within the last 12 years. If, for example, we were at war with Russia—he did not say we were going to be, and he hoped not, but assuming it for the sake of argument—we should naturally have the fleet in the neighbourhood of Besika Bay or the Dardanelles. He would assume that the lines in the Mediterranean were all cut; then a dispatch boat could go to the coast of Greece, only one night's sail from Besika Bay, and they could arrange that by another dispatch boat at Navarino, a telegram sent from the fleet would be within a short sail of telegraphic communication with Italy, from which Gibraltar and other parts of Europe could easily be reached. Therefore, two dispatch boats alone would connect the fleet in the Mediterranean with this country if all the cables were cut. That was assuming that we had friendly relations with Greece; but if that were not so, then much would depend upon what power was friendly with us. If France were our friend, then a steam-boat communication from Besika Bay to Malta would put that within a few hours' sail of Tunis. and a short line from Malta to Tunis, which could be laid in one night, would put us in communication with the whole of the French lines on the coast of Algiers, and then another dispatch vessel by Oran would put us within one day's sail, or would lay a cable to Gibraltar. His argument was that short sections, and as many as possible of them, was the true method upon which cables should be laid, and at all times in shallow water, in which they could be easily recovered for repairs. Were this done, it would soon be of no use for any enemy to try and break cables as far as the Mediterranean was concerned. The same thing obtained as far as Aden. There were excellent landing points at the mouth of the Gulf of Suez, and two more between there and Aden, and in six weeks after notice was given they could lay a cable at every one of those points. It would not be likely that all would be cut at once, and it would only require two dispatch boats at those stations in the Red Sea, in the event of any one being cut, to carry on communication as far as Aden. The same thing could not be done as well from Aden to Bombay, and that part of the line would have to be defended by vessels of war. But assuming we were at war, there would naturally be transports carrying troops, vessels carrying coals and stores of all kinds along that great highway from India to Egypt, and with such a fleet of defenceless vessels we could never be without war vessels convoying those transports, and the same men-of-war which convoyed those vessels would protect the cable. He maintained therefore that cables should be laid along the highway of commerce, where any nations which had any power must protect that commerce, and in doing so it would protect the cables. At all events there was no other way, and no better way, by which cables could be protected. There had been a project several times to lay a cable round Africa to the Cape of Good Hope. But he had, on more than one occasion, expressed himself against it, because he thought it was no good laying cables where there was not sufficient use for them. If they could not lay cables where the commerce went, they could not maintain them at all, and it was not worth trying.

Sir Frederick Goldsmid said, after the very able and interesting paper they had heard, he could add but very little to the subject. He was very happy to corroborate all that required corroboration, and naturally the facts were familiar to him, having had a great deal to do with the matter, the only difference being that during his incumbency he had had the honour of receiving a great deal of abuse, and he was happy to say his successor, Major Champain, was director during the successful operations. At the same time, success or no success, he felt an equal interest in it, and it was as much pleasure to him to congratulate Major Champain on his success as it would have been to be congratulated himself. The point which required to be attended to now was this second line, and to see that they could, by any possibility, connect the line at the head of the Persian Gulf with Europe, independently of Russia, Russia being, at present, rather a precarious country to depend upon for our lines. Even supposing that no war occurred, he still thought they ought to give attention to connecting the lines with the Persian Gulf in Europe by some other means than through that enormous tract of Russian territory. He could not but think it might be easily accomplished. There were others present more competent to speak of it than himself, but he had always been under the impression that they could connect the head of the Persian Gulf with the Mediterranean by a not very difficult process. It was about 500 miles across the desert from Bagdad to the Mediterranean, and he could not help thinking it would not only be worth while thinking about a telegraph, but perhaps about a railway too. If they could, in some way, form an alternative line to the Suez line, it would be well worth our while, without looking at the mere returns in money value of traffic, because it was a very serious question, and one we had, perhaps, passed over without seeing its import. The Euphrates Valley road was an old question, but he did not think it was ever of the same importance as it must appear now, as a means of communication between England and India. We were now confined to the Russian route and the Persian route, but another would be an advantage, and he did not think it would be so very expensive, considering we had a link from Bassorah to Kurrachee, to join at Kurrachee to the Mediterranean.

Dr. Siemens, F.R.S., said the paper was remarkable for its clearness and candour. Everyone who had contributed towards the lines connecting this country with India had had his meed of praise except one individual, who had been very slightly touched upon, and that was the reader of the paper himself. Major Champain had not only been the director of the Indo-European system during its palmy days, but there had been periods in the course of his administration when the days had not looked so sunny as they had generally proved to be by the results. What was more, to Major Champain was due, in great measure, the very fact of this alternative route through the south of Russia, Persia, and Germany. It was in consequence of his initiative that his (Dr. Siemens') attention and that of his brothers was directed towards this enterprise; and having business connections in most of the countries through which these lines would pass, they had less difficulty in getting from those Governments exceptional powers which enabled them to construct a line from London to Teheran which was practically independent of the Government administrations of the different countries through which it passed. This was a great necessity, in order to make a line as efficient as it must be, in order to be a telegraphic highway between such great centres of commerce as London, Calcutta, and Bombay. Major Champain had alluded to the controversy which took place at the time when the two routes were in contemplation, the Eastern u bmarine route and the Indo-European route, which

was essentially a land line. It was fortunate that the prognostications on either side were not verified; the submarine lines had not broken down as frequently as might have been expected at that time, judging by their experience, nor had they on the land-line buried a guard under every telegraphic post as was then prophesied. Both lines had done their work well, and proved, not only that lines by land and by sea might be worked efficaciously, but that two lines were absolutely necessary in order to give safety to telegraphic communication. He did not believe in telegraphic monopolies. If one line only existed between two places the management of that line, although it might be a duplicate line, could not be as perfect as it would if two lines existed. He wholly deprecated competition for cheapness, which to a great extent meant nastiness; but a competition for quality of work, with arrangements for a fairly remunerative traffic, such as would give the public an inducement to telegraph, and make a margin of reasonable profit, seemed to him an essential condition to the advancement of telegraphy. Sir James Anderson had paid land lines rather a high compliment, inasmuch as he foresaw that, in the case of war, the submarine lines would have to be supplemented to a great extent by the land lines, the points of land being connected by means of dispatch boats. He hardly expected to hear that admission from him, because if the lines were laid in tolerably deep water it would not be very easy for an enemy to break such a line. They would not know the locality, and would probably not succeed in breaking the cable unless it happened to be of a very weak description. But however that might be, the traffic between this country and India was pretty well secured even in the event of a Russian war. In making the arrangement for the Indo-European Company's telegraph they took the precaution of inducing the contracting Governments to make a treaty, according to which the telegraph line was guaranteed as a neutral property; and he had that confidence in the Continental Governments, that although they might be at war with this country he thought they would respect an absolute engagement of that sort. Every Monday morning they saw a long telegram in the *Times*, giving very inflammatory war news from Calcutta; they heard of the great enthusiasm for war, and of the desire expressed on all sides to go into combat with Russia. Those telegrams all passed through the heart of Russia, and there had been no word of any interference with them. He firmly believed that if war should break out the Russian Government would respect this engagement for the sake of its own honour, and the people were sufficiently under control, as it happened, in Russia, not to destroy a line which the Government said was necessary to be maintained. He thought it perhaps more likely, and in this perhaps he did not quite agree with Sir Frederick Goldsmid, that a line passing through Asia Minor, or through a country where there was an immense population, would be in greater danger of interruption than where the line was entirely placed under the direction of one Government. However that might be, he hoped with the other speakers that it would not come to an actual war; but, whatever happened, he thought our communication with the East was well secured.

Mr. Hyde Clarke said he was present as spectator at part of the scene when those who had spoken this evening and many of their comrades exposed their lives, and others, like poor Stewart, lost their lives in this service, which was so honourably carried out. He believed the paper which had been read that evening was not only of value in itself for the information it contained, but as laying a foundation in the discussion which had taken place for influences on the telegraph system which were little foreseen. He had listened with deep interest to what Sir James Anderson had said, but there were other public considerations on this question beyond those of the companies with which Sir James Anderson and Dr. Siemens had dealt. The discussion on this question would, to his mind, certainly tend to advance that which must have the greatest influence on the telegraphic system—the question of cheap cables which had been referred to; to that they must come, and on the principle of Sir James Anderson, for that purpose of duplication to which he had referred.

Mr. Fitzgerald wished to ask Sir James Anderson whether the new lines he thought it desirable to lay in the Red Sea might be safely laid, having regard to the coral reefs, which proved so fatal to the first line.

Sir James Anderson said, Yes. It was not the coral reefs which proved fatal to the first line. With reference to one remark of Dr. Siemens', he should like to say that he could cut a cable in any water, whatever the depth, and with any vessel.

The Chairman then proposed a cordial vote of thanks to Major Champain for his interesting lecture. Considering how entirely submarine telegraphy was in its infancy at the time the operations commenced in the Persian Gulf, and the immense physical obstacles which were presented by the state of the country between Fâo and the Russian frontier, they might well think that was a work of which this country might be proud. No one had a more important share in that work than the gallant gentleman who had read the paper, and they would all feel delighted to know that a substantial reward was probably attending his long and valuable services. With regard to the opinions as to the efficiency of the two methods of communication with India, it was quite true each was sanguine about his own, and rather gloomy with respect to the future of the competing system; but the principal objection which could be made to the Indo-European line was the one which he urged about twelve years ago in the House of Commons—the great danger that it might be cut off in the case of rupture with a country like Russia. He was afraid that no sufficient answer had been given to that objection up to this time. It was quite true that Dr. Siemens was sanguine enough to think that the line through Russia would be maintained in case of hostilities, but he was afraid they could hardly expect that. Indeed, only the other day, when there was some very complicated communications going on between Constantinople and this country, the only means of communication for a short time was through one line.

Dr. Siemens—The whole communication was through our line.

The Chairman said that one particular telegram which attracted much attention certainly came by way of Bombay. They must all agree with the principle which was laid down with so much clearness by Sir James Anderson, that their duty was to protect themselves by multiplying lines as far as possible. That idea was supported by the one suggested by Sir Frederick Goldsmid of a line from Fâo to Latakia. The whole of the Levant was a network of telegraphs, connecting Constantinople with Italy, and soon it would be with Egypt, so that if one were interrupted the others would probably be in working order.

The resolution having been carried unanimously,

Major Champain briefly acknowledged the vote of thanks, saying he had found it very difficult to compress into the space of one hour the history of what had taken so many years to accomplish.

TWENTIETH ORDINARY MEETING.

Wednesday, May 8th, 1878; W. Hawes, Deputy Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Baillie, Captain William, 43, Norfolk-square, Hyde-park, W., and Duntsbourn, Cirencester.
Leon, George, 79, Gloucester-place, W.
Milburn, Robert, 63. Queen Victoria-street, E.C.
Notman, Henry Wilkes. F.R.G.S., Cholmley-lodge, West-end, Kilburn, N.W.
Rathbone, Theodore, F.L.S., J.P., Backwood, Neston, Cheshire.
Ronchetti, John B., Bradford, Manchester.

The following candidates were balloted for and duly elected members of the Society:—

Addy, John, Peterborough.
Brown, Charles Henry, 30, Alexandra-road, Southport, Lancashire.
Hertslet, George Thomas, Lord Chamberlain's-office, St. James's Palace, S.W.
Hirst, William Henry, 125, Mottram-road, Stalybridge.
Hudson, Col., Army Clothing Department, Pimlico, S.W.
Merton, Emile R., 161A, Piccadilly, W.
Ramsden, Sir James, Barrow-in-Furness, Lancashire.
Sykes, Thomas H., Cringle-house, Cheadle, near Manchester.
Wilkinson, M. A. Eason, M.D., F.R.C.P., Greenheys, Manchester.

The paper read was—

THE PHONOGRAPH.

By W. H. Preece.

The science of acoustics has taken most marvellous strides within the last few months. We have already had in this room a description of the telephone itself. We have, in addition to that, another instrument that has created a great deal of sensation, and which I shall have the pleasure of bringing before you to-night. But besides the telephone and the phonograph, there are other wonders in store. There is an instrument—which has not yet come from the other side of the Atlantic—called the aerophone. The aerophone is an instrument that enables the voice to be heard at a distance of four miles. On the other hand, we have within the last few days produced in England an instrument that will be brought before the Royal Society to-morrow night, which is called the microphone. The microphone is an instrument which acts towards the ear as the microscope does to the eye. It will render evident to us sounds that are otherwise absolutely inaudible. I have heard myself the tramp of a little fly across a box with a tread almost as loud as that of a horse across a wooden bridge. There was a remarkable sound that accompanied the tramp of Mr. Fly, and a facetious friend of mine told me he thought the noise was occasioned by the neighing of the proboscis of the fly. Between the microphone on the one side and the aerophone on the other, we have, occupying a middle position, the instrument I have to bring before you to-night. All these instruments depend upon the operation of that marvellous force, if we may so call it, which we call sound. If I ring a bell, blow a musical instrument, or strike anything, what is it that has happened, which passing from me to everybody's ear in this room has produced that sensation which we call sound? I know you are all anxious to see the phonograph in operation, but I think it is just as well to make you acquainted shortly with the principles on which the phonograph works, for if you comprehend the principles, you will, to an infinitely greater extent, admire the instrument itself. So let us ask ourselves, what is this thing which we call sound? Sound of any kind is reducible to motion. The motion of matter is necessary and essential for the production of sound, and the motion of the air, the air that surrounds us and which we breathe, that bathes everybody in this room, is essential for the production of that operation which is now taking place in my throat. I am rather sorry to find that it is still daylight to a certain extent, but I am in hopes if the gas is put down I shall be able to give you a little notion of what sonorous vibration is.

Our notion of waves is derived from what we see upon the sea shore; we see there a motion of ascent and descent, accompanied by a motion of translation, but in this room, although at the present moment while I am speaking to you the air is chased and engraved in the most exquisite manner by the undulations I am imparting to it, all this is invisible to us, and it must so remain. All that we can do is to give you a faint conception of how this air acts. If you could see a tube of air, for instance, coming from my mouth to any one of your ears, then that tube of air, by every sound that is uttered, is thrown into vibration. But it is not a vibration of ascent and descent like the waves of the ocean, but it is an excursion to and fro, and between me and the end of the room, for every sound I utter there is in every particle of air an excursion to and fro. Now, notes or sounds vary in three particular ways.

In the first place, we have the pitch of a note. The pitch of a note is that which determines whether it shall be A, B, or C, or any other note of music; and the pitch of a note is the number of vibrations that are made per second, or, in other words, the length of the wave. So that the first property connected with notes is that of their pitch, and their pitch depends upon the length of the sonorous wave.

The second property of sound is that of loudness. I can speak to you softly, I can speak to you loudly; you can hear the note of a piano gently played, you can press the pedal, and you can hear it loudly played. You can produce sounds that vary in intensity between great extremes, and the reason why one sound is greater than another is, that the amplitude of the excursion of particles of air are greater in one case than in the other; in other words, their velocity being different they hit the drum of the ear with greater force. In the same way, if you take a common smooth-bore gun which drives a ball with the initial velocity of a few feet, and you take an Armstrong gun, which drives the ball with a velocity of 1,500 feet, in the one case you have the ball making an indentation in a metal shield, while in the other case you have the ball sent right through the shield. So when you utter sounds softly, the tympanum of the ear is struck gently; and when you utter sounds loudly, the ear is struck with greater force. The loudness of sound is dependent upon the amplitude to and fro of the particles of air.

But there is a third property of sound, which is one of its principal properties, the one which distinguishes one voice from another, that dis-

tinguishes the note C on the violin from the same note on the piano; the cause of the difference between the sound of the drum and a cornet, and all the differences that occur between various sounds. All these differences are solely dependent upon the form in which the waves take their excursion to and fro. They may jerk to and fro, they may move gently forward and back again, with a high velocity or a low velocity, and so they may vary their mode of excursion to and fro in innumerable forms and produce various shades of intonation and articulation. So that we have, first of all, the pitch of a note which depends, as I told you, on the length of the wave; secondly, the loudness of a note, which depends on the amplitude of the excursion; and, thirdly, the quality of a note, which depends upon the form of the wave.

I will endeavour to give you an idea of what a sonorous wave is. On this screen you will see a little spot of light. I am not sure that the light is visible to the whole of the room, but that little spot of light is supposed to represent a particle of air now in a state of quiescence in some part of this room. If we move the slide up and down, you will see it takes a motion backward and forward, which represents very roughly the movement to and fro of the particles of air between me and the end of the room. The next slide shows a portion of the supposititious tube of air, including several of these particles, and in this I have endeavoured to illustrate to you what takes place to form a wave. A wave means a succession of lines of compression and of rarefaction. Since there is no up and down movement like the waves of the sea, there is an excursion to and fro, which excursion results in a series of compressions and rarefactions. Now, if we move that slide up and down, you will see passing over it a series of waves, and those waves are simply a series of condensations and rarefactions. They are very erratic, and rather crude, and I should be very sorry indeed for anybody to imagine that what you see on the screen is an actual representation of what takes place in nature. Nature in all her laws is beautiful, but in this poor attempt to illustrate her laws, we have nothing but what is crude and rough. It is, however, an attempt to bring before you what is taking place in this room. That shows what takes place in only one line beween my mouth and any ear in this room. But there are millions upon millions of particles going through the same operations of condensation and rarefaction, which you see. When the mind attempts to fix itself upon what takes place in this air, when you endeavour to picture what is going on in nature, you become lost in the effort.

I am now going to show you how matter itself vibrates when you put it in a line of these moving particles. Here is another rough attempt to show you what really occurs, but this is not an effort to induce you to exercise your imagination, but to show you actually what takes place when one speaks at an elastic medium. Now, Mr. Stroh has in front of him an india-rubber diaphragm, upon which is fixed a mirror, and this mirror will reflect upon the screen a spot of light. You will see that, as he sounds a note, the diaphragm vibrates, giving evidence of its vibration by the motion of the spot of light. If, while he sounds the note, he moves backwards and forwards, the spot of light is thrown across the screen, and you find there is an illustration of what I told you, that the note is simply dependent upon the number of vibrations per second; for, if he sounds a low note and then a high note, the difference in vibrations will be apparent to you.

I do not know whether those experiments were sufficient to illustrate to you two facts—first, that sound is produced by the vibration of the particles of air; and, secondly, that objects placed in these paths of vibrating air can themselves be vibrated. It is said that Lablache could sound a note so loud and strong that he could crack a tumbler; and in the Midland Counties there is a serjeant-major of a volunteer corps who is often brought into the room after mess to crack a tumbler in this way. So far as regards the production of sound.

Now, one or two words about the transmission of sound, before we come to the phonograph, which, doubtless, you are all anxious to see. The transmission of sound is twofold; we can have the mechanical transmission, and we can have the reproduction by electrical means. In the earliest days of civilisation, the ancient Greeks acquired the art of transmitting sound, and there were actors who addressed the audience through speaking trumpets. With these they marched up and down the stage, directing their speeches by this means to the furthest end of the theatre. I do not think in the present day we could stand Mr. Henry Irving reciting "To be, or not to be," through speaking trumpet.

Amongst the proposals to transmit sound, there is one very interesting record of that marvellous old gentleman, who lived some 200 years ago, Mr. Robert Hook, and invented what we know now as the toy telephone. He found that sounds could be transmitted round corners, and to a distance of a hundred yards, by means of diaphragms and wire. Wheatsone, within our memory, produced his telephone, which succeeded in transmitting from the lower to the upper regions—from the cellars of the Polytechnic to the galleries above—musical sounds with all their beauty and variety. We have all doubtless spent our shilling at the London Stereoscopic Company, in buying the toy telephone, which brings before us all the notions I have to bring before you.

The electrical transmission of sound was inaugurated in the year 1860 by a German of the name of Reiss, who showed how, by taking advantage of that vibrating disc, which Mr. Stroh just now showed you, to complete and make a circuit, you could make sounds be heard at a distance. Reiss succeeded in transmitting music, and Gray, of Chicago, succeeded in doing the same. The climax was gained when Professor Graham Bell produced his speaking telephone. About twelve months ago, or, perhaps, a little more than that, I do not believe there was a man in England who believed that it was possible to carry the voice a distance of 50, or even 20 miles. A little more than twelve months ago, I did not believe it myself. I went over to America in the early part of last year, especially to inquire into those advances in telegraphy which our friends on the other

side of the Atlantic had made, and when I went there I fully expected I should have the pleasure of exposing the telephone. I had not been there long before I met Professor Bell. I saw his telephone, and I became a convert. I may mention that it was my special pleasure to be the first person to bring this instrument to England; I exhibited it at the meeting of the British Association at Plymouth, and gradually the fact has dawned upon every one, that it is possible to convey the human voice from one spot to another. Well, others have worked in this field. Edison has worked in the footsteps of Professor Bell, and as the outcome of it, he has produced the phonograph. Professor Hughes is the gentleman who has succeeded in making us hear the fly walk, and others are working in the same line. What I want you to clearly understand is this, that all these instruments, whether it be the microphone of Professor Hughes, the telephone of Professor Bell, the aerophone of Mr. Edison, or the interesting instrument behind me, the phonograph, they all depend on this one simple, wonderful fact, which, to my mind, is one of the greatest discoveries of this age, namely, that a mere vibrating diaphragm can give us all the articulation and all the variety and beauty of the human voice. I am sure there is scarcely a man in England who would have believed six months ago that it was possible for a diaphragm of this kind to reproduce the human voice. Certainly, men like Sir Charles Wheatstone and others, who devoted the best part of their lives to perfecting the speaking instrument, would have thought us stark staring mad if we had told them that the whole beauty of the human voice would ever be reproduced by a plain, simple diaphragm.

Now, in some of the instruments which I have mentioned to you, I have referred to the use of electricity and the use of magnetism, but in the phonograph, to which I am coming, we have neither electricity nor magnetism; and I want at once to disabuse your minds of the idea that there is any electricity used with it, because one of the first questions which is usually asked me is, where is the magnet? There is nothing of the sort here; it is simply a mechanical contrivance. We have merely to insert a diaphragm in the paths of the sonorous vibrations emitted from our mouths, to produce motion. Philosophers have taken advantage of this motion to record sound, and to produce an instrument called the phonautograph.

Mr. William Henry Barlow, one of our most eminent engineers, produced what is termed the logograph, that being an instrument which recorded, not the sonorous vibrations properly of the mouth, but the variations of the air pressure in the immediate vicinity of the mouth. On the diagram to your right there is an enlarged representation, on Mr. Barlow's logograph, of the line, "The minstrel boy to the war has gone—In the ranks of death you'll find him." There you will see depicted in curves the different sounds uttered by the voice. They give you, in their amplitude, the loudness of the sound; in their length, the pitch of the sound; and in their form, the quality of the sound—the *timbre*, as the French call it. From this we spring at once to the phonograph, of which we have now all the elements before us. The phonograph was discovered, like many other things, by mere chance. Edison himself was experimenting with the telephone, trying all kinds of experiments, as all of us have been doing, to improve the telephone; in doing so, he pricked his finger, and, drawing it rapidly away, a line was made on his finger. This gave him the notion that if the diaphragm of a telephone could mark his finger, why should it not mark paper, and if it marked paper, why could the sound not be reproduced? So he took a piece of Morse paper and inserted the diaphragm of the telephone, where the ordinary style of the Morse instrument is, and there he found on the paper, when he uttered the words, "Halloa! halloa!" distinct marks, varying dots and dashes, or a series of dots. Then he took this strip of paper and allowed it to pass back again. He simply reversed the process, and instead of making the diaphragm vibrate with his voice, by passing the paper back again in the reverse direction, he caused the paper to make the diaphragm vibrate, and the result was, he heard a faint "Halloa! halloa!" come out of the diaphragm. This was a glorious triumph for Edison. It occurred on a Wednesday afternoon. He worked at it all the Wednesday, all Wednesday night, all Thursday, and Thursday night, all Friday, and Friday night incessantly, without eating, drinking, or sleeping, until on Saturday morning he produced his first phonograph. I have on this diagram a drawing of this first phonograph. His difficulty was, having secured the principle of the vibrating diaphragm, to procure some substance which would retain those marks. By a happy inspiration he almost at once lighted upon tinfoil. Tinfoil is in itself a highly inelastic substance, and is not only very inelastic, but is a very yielding substance. Any mark made on tinfoil remains impressed there, and will remain there for an indefinite period. He then made a cylinder of brass, which he covered with a sheet of tinfoil. The cylinder was centred on a screwed axis supported by bearings, and was rotated by a handle at the extreme end. A heavy fly-wheel was attached to it to secure uniform velocity, and there you have all the mechanical contrivances required to make a phonograph. The mode in which it moves is shown in this section on the lower part of the diagram, which is a section taken through the diaphragm of the cylinder. It shows here the section of a diaphragm with its point behind it, the rough end of the cylinder depicts the vibrations, and the forms that are marked on the tinfoil somewhat similar to the forms that are marked on Mr. Barlow's logograph. The great difficulty that persons at first have in following the description of the phonograph is this. We can all very readily see how the vibration of a diaphragm can make marks upon tinfoil, but it is not so easy to see how it is that when you reverse the process these marks on the tinfoil reproduce or repeat the same vibrations. We fancy that the effect of reversing this process, and passing the tinfoil under the diaphragm, would be not to make the diaphragm vibrate, but to rub out the marks on the tinfoil. But the marks are not rubbed out. It appears that the resistance which the diaphragm makes to the vibrations caused by the marks on the tinfoil is very slight, and the same piece of tinfoil can be used over and over

again. I have used the same piece as many as 20 times, with a very slight difference in the intensity of sounds produced. The fact remains, that when you pass this marked tinfoil a second time beneath the point at the back of the diaphragm, it then causes the diaphragm to vibrate in exactly the same way as it vibrated under your voice, and the result is if you cause the diaphragm to vibrate in the same way that it vibrated under your voice, you get precisely the same notes, of the same pitch, and the same quality as were contributed to it by your voice. I do not know whether I have made myself clear, but if I have not the instrument shall speak for itself. Here we have the latest form of instrument. It is made by one of the first mechanicians in this country, Mr. Stroh, for the London Stereoscopic Company, who have secured the right of using the phonograph in England, and to whose courtesy and kindness we are indebted for its exhibition to-night. It differs considerably, as you see, from the instrument I have described to you, viz., Edison's first instrument, although it is essentially the same in principle. One great defect in the instrument shown on the diagram, is that you cannot ensure the same velocity of rotation in the cylinder when the sounds are repeated as it had when the sounds were given to it. It requires great delicacy, and a great deal of experience to rotate an instrument of the kind with uniform velocity by the hand, although aided by a fly-wheel. Here, by an exceedingly pretty contrivance, there is a falling weight, which, by an endless chain, and two or three wheels, imparts rotation to the cylinder, and it has this governor above it, these expanding wings, which, by their resistance to the air, give to the instrument what it wants, namely, uniform velocity. The result is, that when you speak into this instrument, you obtain very nearly a reproduction of the sounds emitted—very nearly, not quite. The instrument has not quite reached that perfection when the tones of a Patti, or the speeches of a Gladstone, or the sermons of a Liddon, can be faithfully repeated; in fact, to some extent it is a burlesque or parody of the human voice. You have heard me speak for so many minutes that you will be able to judge how far the instrument will reproduce my own voice. It gives off musical sounds admirably, but unfortunately I am not a musician. I am like the gentleman who only knew two songs, one of which was "God save the Queen," and the other was not. I do not know the song that was not, so I will presently give you "God save the Queen," but before we come to that, we will try some poetical quotation, or some learned aphorism, and see what the effect will be.

[Various experiments were made with the instrument, which reproduced some lines of a nursery rhyme, some remarks made by the Chairman, a verse of "God save the Queen" sung as a duet, the notes of a bugle, some imitations of animals, &c.]

I dare say many of us have thought to ourselves, what uses can this instrument be put to. Now, it is quite evident to you that though the production of sound is very wonderful, it is not very perfect; in fact, there are some consonants that are wanting altogether. The *s* for instance at the beginning and end of a word is almost entirely lost—is entirely lost, although it is heard slightly in the middle of a word. The *d* and the *t* are exactly the same; and the same in *m* and *n*, *mane* and *name* are not distinguishable. Hence, it is extremely difficult to read what is said upon this instrument; if a person is put out of the room, and you speak into it, he can with difficulty translate what it says. Still, I read distinctly on the first instrument sent over from America to me, a message that was sent to me by its inventor, Mr. Edison. It said distinctly, "How do you do? What do you think of my phonograph?" Those words were spoken into the instrument in New York, were carried across the Atlantic, and, more than a fortnight after they were uttered, I heard and translated them. But the principal purpose to which it was thought that it could be applied, viz.: to dispense with our friends the shorthand writers, is, I am afraid, still very far in the future. It has been proposed to fill libraries with speeches, with sermons, with plays recited by eminent actors, but the instrument has not yet reached that stage when such a thing is probable. It remains an extremely interesting scientific toy, a wonderful novelty. But it is only a chick. It is only three months old, and if it can do what you have heard to-night when three months old, what will it do when three years old? One of the purposes to which it is proposed to be applied is this. This is what Edison says:—"I saw the President of the American Philological Society the other day, and he had a conversation with a Portuguese who was in the room through the phonograph. He wants one of my improved phonographs to preserve the accents of the Ormandagas and Tuscaroras, who are dying out. One old man speaks the language fluently and correctly, and he is afraid he will die. You see, one man goes amongst the Indians and represents the pronunciation of their words by English syllables; another represents the same words differently; there is nothing definite. The phonograph will preserve the exact pronunciation, and the President of the Philological Society means to travel with it amongst all the North American tribes." And so if men in future ages want to know how our Chairman pronounced the English language, or how your lecturer sang, we have only to hand down to posterity this piece of tinfoil.

I do not think I can show you any more of the wonderful performance of this instrument collectively, but we will keep it going for your amusement for some time. I am much obliged to you for the attention you have bestowed, and I must say I have felt great pleasure in bringing the phonograph before the Society of Arts. The inventor of it was kind enough to send me the second instrument that was ever made, and it has been my privilege as well as my great pleasure to bring his wonderful invention before the British public.

The Chairman said he had two duties to perform; one to invite discussion on the paper, which seemed almost impossible, for very few present could have sufficient knowledge of the machine, or the principle upon which it was constructed, to discuss it; and the other to ask the meeting to return a cordial vote of thanks to Mr. Preece, for the exceedingly able manner in which he had brought the subject before them. If, however, any one should desire to ask for any further information, he was sure Mr. Preece would be happy to answer any

questions which might be put. It was a great privilege for the Society of Arts to receive, as it had done that session, two papers upon such novel and interesting subjects as the telephone and the phonograph. If anything were wanted to show the importance of the Society, and the respect to which it was entitled, it was supplied by the fact that such subjects were brought forward, and laid before the public in the manner in which they had been by Professor Bell and Mr. Preece. Great praise was due to the latter gentleman for the quiet, unassuming, and lucid way in which he had treated his subject. It was another step in the knowledge of nature, and in those discoveries in which the present age had been so fruitful.

The vote of thanks having been passed,

Mr. Preece, in returning thanks, remarked that one peculiarity of this instrument seemed to be that it possessed great intensity of sound, and whether it were used in a small room or a large one, it seemed to fill up the whole space. He had used it in rooms twice or three times the size of that, and every person present had heard it as distinctly as they had on that occasion.

ADDITIONAL LECTURES.

EXPLOSIONS IN COAL MINES.

By T. Wills, F.C.S.

Lecture III.—Delivered Feb. 11th, 1878.

The four forms of safety lamps described in the last lecture are types of a very large number of lamps which have, from time to time, been introduced; each form of lamp has its own advantages, but no lamp is to be found the use of which, under all circumstances, is quite free from danger.

Lamps of the original "Davy" form are the most liable to permit the passage of the flame through the wire gauze.

In the "Stephenson" lamp a danger is apt to arise from the irregularity of the holes in the plate, or plates, through which the air enters; these holes are drilled by hand, and under these circumstances their accuracy cannot be ensured to the same extent as in the machine-made wire gauze. A "Stephenson" lamp requires to be held in a nearly vertical position.

In the "Clanny" form of lamp the imperfect supply of air is a difficulty, as it is attended with a loss of light. That this is the case is well illustrated by comparing a "Clanny" with a "Mueseler," in which it is found that, the two lamps being almost of the same character, the better air supply in the "Mueseler" is coupled with an increased amount of light.

The following comparative experiments, which were made with a view to these lectures, exhibit the relative photometric value of these four lamps; the loss of light is also shown when the flame is surrounded by the gauze, or gauze and glass:—

A Sperm Candle burning 120 *grains per hour* = 1 *Oil Lamp.*

			Loss or gain in light on surrounding the flame with the upper part of the lamp. Per cent.
"Davy"	Naked	= ·398	
	Complete	= ·146	= 63 loss.
"Stephenson"	Naked	= ·366	
	Complete	= ·131	= 64 loss.
"Clanny"	Naked	= ·378	
	Complete	= ·296	= 21 loss.
"Mueseler"	Naked	= ·368	
	Complete	= ·385	= 4 gain.

The observations were made by means of a Bunsen's photometer, and the lamps used were ordinary working lamps, but new.

In this table it is seen that, when the naked light is enclosed within the lamp, there is a considerable loss of light in each case, except that of the Mueseler, and the remarkable difference in this instance must be attributed to the more perfect supply of air in this lamp. Practically, the placing of the glass and gauze round a Mueseler lamp makes no difference in the amount of light obtained.

Occasionally, for special purposes, shields or reflectors are placed entirely or partially round the lamps on a level with the flame, but their advantage is very doubtful. Before quitting this subject, a form of lamp, which is in extensive use in Scotland, must be mentioned. This lamp is called a gauze lamp, and is of a somewhat primitive construction; it is much larger than the other forms of lamps, the outer case consisting entirely of unprotected gauze. This gauze cylinder is about 8 inches high by 3½ in diameter; a lamp with a flat wick is used, and more light is obtained from it than from the ordinary Davy, but its safety is not so great; the considerable space within the lamp forms an element of danger in the event of its being exposed to an explosive atmosphere. This description of lamp was in use at the Blantyre Colliery when the terrible explosion took place last October.

Vegetable oils are mostly used in lamps, but in some cases the rock or mineral oils have been substituted; there is a prejudice against these latter which has prevented their common adoption, although the saving in cost, the cleanliness in use, and the much greater amount of light obtained, are decided advantages; it is probable that these important considerations will eventually lead to their more general use. A lamp burning a mineral oil gives more than twice as much light, under the same circumstances, as one of the ordinary character. Some lamps burning the lighter mineral oils are constructed without wicks, a small piece of cotton wool or sponge serving the purpose of a wick for an indefinite length of time. When lamps are used with these oils, care and caution must be exercised in the storage of the material, and in the filling of the lamp.

Although the introduction of the Davy lamp marks a very important era in the working of coal mines, it singularly happened that instead of at once largely decreasing the accidents from explosion, these in the immediately succeeding years became greater. The Davy lamp was introduced and adopted in 1815, in the 21 years previous to which the average annual loss of life by explosion was 23, but in the 15 years subsequent to its invention there was an increase, the yearly destruction being 28; this fact, although remarkable, is accounted for by the false notion of absolute security in the use of a Davy lamp which was held at the time, and which led to the immediate opening up and working of dangerous places which had previously been abandoned.

Dangers Connected with the use of Safety Lamps.

From what has been already said it will be gathered that safety lamps can be by no means implicitly trusted to prevent an explosion; much care is required in their construction and use, as

any defect or failure in the lamps may be, and frequently has been, the source of much danger. Every lamp supplied to a mine should, in its vital part, be of the best manufacture, and much care should be taken in putting the various parts of the lamp together. Lamps as a rule do undoubtedly leave the workshop in an excellent condition, but occasionally, from some perhaps exceptional cause, a defect occurs, which if not afterwards detected may be the source of accident. A short time ago some Stephenson lamps were tested in the North of England, and in one batch several lamps were found which would kindle an inflammable mixture on the outside with the greatest ease; the Stephenson is liable to this defect owing to the difficulty (already mentioned) of making the small holes uniform. It may be suggested whether it would not be possible to practically test every lamp in an explosive atmosphere before it is sent away from the manufacturer's premises. The defects in the lamps which occasionally occur during the manufacture, are, however, of small moment when compared with those that arise afterwards through the wear and tear of use. After every time of using, a lamp should be thoroughly inspected; this is, at the present time, supposed to be carried out. The Coal Mines Regulation Act requires the lamp to be inspected by a competent person before such lamps are carried into the workings, but in too many instances this inspection is the barest matter of form; perhaps hundreds of lamps have to be examined within a very short time, and the most casual observation has to suffice; it is by no means sufficient to observe whether the lamp is locked or not, the state of the gauze, and of the lamps generally, requires more than a superficial examination. Want of cleanliness is in itself a source of evil. If oil and dirt be allowed to remain on the gauzes, apart from its rapidly causing deterioration, it is found that a flame will more readily pass through such a gauze; a lamp should also be properly trimmed before entering the mine, as in this way the temptation which a miner has to open his lamp to improve the light is lessened. It is the custom in some districts for the miners to provide their own lamps and to retain them in their possession when not in the pit; this, without doubt, is a bad practice; it cannot be expected that a miner will go to more expense than he can help, and as to him probably all lamps are pretty much alike, he is sure to get one from a fellow miner, or from some second-hand store. The care and cleaning of the lamps also is not well left to the miners themselves; a properly authorised and competent person or persons should have the entire control of the lamps when not in use. A miner's notion of cleanliness is not always satisfactory. An instance occurred in the North in which a miner, in order to cleanse the gauze of a lamp from oil and dirt, removed it and thrust it into the midst of a fire, replacing it after the combustible matter had been burnt away; it need hardly be stated that such a gauze would afterwards be most dangerous, both from the enlarging of the holes, and from the extreme brittleness of the wires. Another and much to be regretted cause of danger in the use of safety lamps arises from unauthorised tampering with the lamps; opening a lamp in an unsafe pit is a most serious evil, and when the trivial causes are considered for which this is done, the subject is rather disheartening. Smoking is one of the most general causes of opening the lamps, and although in most cases strictly and wisely prohibited, is a source of constant trouble, and it is to be feared will continue so until the miners can be made to feel their responsibility. Rules and regulations on the subject are evaded in the most terribly reckless manner, even in circumstances where it might be supposed the miner's own knowledge would quicken his sense of danger. Where the wilfulness or negligence of one man may bring disaster and possibly destruction to large numbers, it is surely no injustice or hardship to ask that when such a case is discovered, and the offender is called to account, a severe punishment should be inflicted; too often, however, such culprits escape with the payment of a slight fine. Within the last fortnight (January 23rd) two miners have been fined at the Burslem Police-court for actually smoking in a place in a mine in which at the time there existed explosive gas. A pipe may be lighted from an ordinary Davy lamp without opening it, if the lamp be tilted on one side and the pipe is placed close against the gauze; the operation is, however, by no means free from danger if gas exists in the neighbourhood; to obtain a light from the other descriptions of lamps, the lamp must be taken apart. The lighting of pipes, although the most general, is not the only cause of tampering with the lamp, the small amount of light which even the best of them give, offers an inducement for the removal of the gauze in order to obtain the full benefit of the naked light, also when the fuse of a blasting shot has to be fired frequently the lamp top is removed; this is not really necessary, as a hot wire, which may be heated through one of the meshes of the wire gauze, would be quite sufficient. Special care is necessary with the lamps on the occasion of shot firing, as it may be the case that while there is no appreciable amount of gas near the spot before the explosion, this state of things may not exist afterwards, and supposing a lamp to have been taken apart and not put together again, a serious result may follow. It is certain that this tampering with the safety lamps by those who should exhibit the most care forms one of the most serious evils against which colliery proprietors have to contend; experience, which is generally the most successful teacher, seems here to fail, and the plea of ignorance in very many cases cannot certainly be justified. An incredible number of cases of the most reckless carelessness, resulting sometimes in a catastrophe sometimes not owing to circumstances out of the miner's knowledge or control, might be placed on record, if any good might be hoped from so doing. This state of things has rendered it necessary that any precautionary measures which can be applied to the lamp itself shall be adopted, and hence in all lamps ordinarily in use in any fiery mine a locking arrangement is attached which is intended to prevent the lamp from being taken apart with impunity, so as to expose the light, or if so taken apart, to ensure that the fact shall afterwards be revealed. This affords a certain measure of safety, but entire reliance upon it has, in most cases, become a trust in a very broken reed. Various locks have been introduced, each claiming special advantages, and many forms are in constant use; they are intended

either to prevent the lamp from being opened at all except by authorised persons, or if taken apart, to cause the fact to be afterwards readily detected; or lastly, if an attempt is made to expose the light, to cause it to be extinguished in the operation.

The Coal Mines Regulation Act requires that "In every working approaching any place where there is likely to be an accumulation of explosive gas, no lamp or light, other than a locked safety lamp, shall be allowed or used; and whenever safety lamps are required by this Act to be used, a competent person, who shall be appointed for the purpose, shall examine every safety lamp immediately before it is taken into the workings for use, and ascertain it to be secure and securely locked, and in any part of a mine in which safety lamps are so required to be used they shall not be used until they have been so examined and found secure and securely locked. and shall not without due authority be unlocked." The locking arrangement here contemplated is undoubtedly some apparatus which shall prevent the exposure of the flame by an ordinary miner. The readiest method, and the one largely adopted for this purpose, is so to fasten the upper part of the lamp or gauze cylinder to the lower part or lamp vessel, that the two cannot be separated without a key or special instrument, to be retained by those with whom the authority rests. The ordinary "screw" lock is an illustration of the way in which this is practically done. The two parts of the lamp are joined by a screw thread; above or below this thread is a groove cut round the circumference, the upper part of the lamp carries a counter sunk screw plug, which, when the lamp is fitted together, can be screwed into the groove, and afterwards the lamp cannot be separated or opened without the first removal of this plug. The success of this arrangement, as far as the tampering with the lamp is concerned, depends almost entirely upon the kind of key required to loosen this screw plug; usually this key is simply a piece of round iron or steel with a slit in it, fitting to the head of the screw, the imitation of which is most easy, and a variety of impromptu instruments may be substituted for it, such as an iron nail or a penknife with a slit cut in it, or two nails fastened together, &c.; also after a time the screw is apt to become loose, when not even these means need to be resorted to to open the lamp, as the point of almost any solid body can be made to turn the screw sufficiently to allow the lamp to be taken apart. The largest number of locks adapted to ordinary safety-lamps are of this pattern, which it must be acknowledged is not by any means satisfactory. It is rather sad to have to admit that so little faith can be placed in miners with respect to this matter of locked lamps, for it appears that, however carefully a lamp may be so guarded, the ingenuity of the workmen will compass the matter, and find a means of breaking the rules. At an explosion which took place at Talk'c-o'-the-Hill, in 1867, in which 80 persons were killed, 27 false lamp keys were found on the bodies.

In some forms of lamp a powerful spring replaces the screw plug ordinarily used.

Magnetic locks have also been proposed, and occasionally used, an iron bolt fastening the lamps together, which can only be withdrawn by the action of a powerful magnet; practical difficulties, however, occur in this arrangement.

In the Scotch gauze lamps a simple padlock, passing through two eyes, one in the upper and the other in the lower part of the lamp is used.

Other forms of lock seek to prevent the tampering with the lamps by rendering detection certain, on which, of course, a severe punishment should follow. One form of these "detector" locks consists in joining the two parts of the lamp together with a bayonet joint; when this is done a lead plug is passed through an eye in each part, and, by a pair of nippers, is squeezed together, and impressed with some form of seal. Before such a lamp can be opened, this lead plug must be cut, and its replacement, if it carries a stamp, is difficult.

As the aim of all forms of locking apparatus is to prevent the exposure of the light, attention has been given in many cases to some arrangements whereby the light shall be extinguished whenever the lamp is opened. In some, by means of a lever an extinguisher is brought down upon the wick when the oil vessel is unscrewed; in oil lamps, however, apart from the difficulty of maintaining the apparatus in working order, the flame is apt to be persistent, and if the operation of opening is done quickly it may still be alight when the lamp is taken apart. In lamps burning mineral oil, the effect can be more easily accomplished, and a lamp, the flame of which is always extinguished before it can be exposed, has lately been introduced called the "Protector" lamp; this lamp is the invention of Mr. W. E. Teale, to whose kindness I am indebted for several of the specimens exhibited. Surrounding the tube of the lamp carrying the wick is a second brass tube; before the lamp can be opened the oil vessel has to be unscrewed from the body of the lamp, this operation draws the wick and the flame down through the outer tube, the proximity and cooling effect of which invariably extinguishes the flame before it can be withdrawn; a spring bolt retains the outer tube in its place, and the bolt can only be released after the lamp vessel has been taken apart, and, consequently, when the flame is out; in practice the lamp works quite successfully, and I believe its adoption is increasing. Any of the ordinary forms of locking apparatus may be attached to it, but without these means it would appear to fulfil the spirit of the Mines Regulation Act, if not the letter.

I pass now to another source of danger in the use of safety lamps. If a lamp is exposed too long to an explosive atmosphere, the gauze will become red hot, and in this state may kindle the outer mixture, or the rapid oxidation of the gauze may impair it to such an extent as to increase the size of the apertures, so that the flame may pass through; a lamp introduced into a mixture of fire damp and air is at once filled with the mixture which burns within the gauze. When such a state of things occurs, means should at once be taken to extinguish the lamp, the wick should be drawn down, by means of the trimming wire, until the oil flame is out; if the amount of fire-damp in the air is not very large, the burning mixture within the gauze will go out at the same time, but it may, and sometimes does happen, that the combustion within the gauze still continues. This state of things is very critical, and prompt measures must be adopted to prevent the heating of the gauze to redness, which would speedily take place. The

lamp in such a condition should be moved as little as possible, it may be smothered out either under a coat, or by burying it under loose coal or dust, or plunging it into water; cases have been known, indeed, even when this has been done, in which lamps buried under the dust of the roadway have been found still alight a considerable time afterwards. The special danger here alluded to depends considerably upon the character of the fire-damp mixture, and to some extent also upon the lamps. The Stephenson lamp is usually extinguished if there be but a small proportion of fire-damp present. When the oil flame is extinguished, the combustion within the gauze will be extinguished at the same time; if there be a very large proportion of fire-damp, more than 1 to 6 of air, then no danger will arise, as the flame will be extinguished, and no burning will take place within the lamp. A miner who finds that after the extinguishing of the oil flame there is still combustion within his lamp, should regard the matter as critical, and use all his presence of mind in making an attempt to smother his lamp out.

Working should never be permitted at all in atmospheres containing large quantities of gas.

The next two causes of failure of lamps are not so absolutely under control as the former.

It has been known for a long period that lamps are not safe if exposed to an explosive current travelling at a rapid pace past the lamp; under these circumstances the flame is sometimes carried bodily through the gauze, and communicates combustion to the exterior atmosphere. The explanation of this fact is not difficult. The efficacy of the safety lamp depends upon the cooling effect of the wires of the gauze, this cooling effect lowering the temperature of the burning gases below that at which they can communicate combustion to the mixture outside; for this effect, however, to take place, the gases must be in contact with the cooling surfaces for a definite time; if this be not the case they may pass through at a temperature still high enough to inflame the explosive atmosphere; a rapid draught through a lamp tends to produce this result, and the important point to be determined is the precise rate at which the current must be travelling.

A committee was appointed by the North of England Mining Institute, in 1867, especially to investigate this subject, and its report is interesting and valuable. A large number of experiments were made, a few with fire-damp, the majority with ordinary coal gas; some slight inaccuracy is to be expected from the use of coal gas, as the temperature required for its inflammation is lower than that required for actual fire-damp. The general result of these experiments was to show that a current of explosive gas, travelling at the rate of from 7 to 9 ft. per second, impinging upon a safety lamp, would cause the flame to pass through the gauze and ignite the outer mixture. Mr. W. Galloway, of Cardiff, has repeated some of the experiments with fire-damp, and has come to very much the same conclusion, *i.e.*, a velocity of from 7 to 8 ft. per second. In the experiments of the committee above referred to, a record was kept of the length of time during which the experiment lasted as well as the velocity; the importance of this is readily seen, although no special stress is laid upon the matter in the report. The longer the experiment lasts the hotter will the gauze of the lamp become, and its cooling influence will to the same extent be impaired. When this is the case, it is to be expected that a lower velocity of the explosive current will suffice to pass the flame through the gauze than before; this is seen to be borne out by the following figures taken from the record of some of the above experiments:—

	Velocity of Current at which passage of flame took place in feet per second.	Duration of experiments in seconds.
Davy lamp	13·6	6
Do.	7	12
Clanny lamp	10	20
Do.	9·6	43
Do.	9·0	45
Do.	8·5	48
Stephenson	12·7	7
Do.	11·3	12
Do.	11·3	29
Do.	10·3	52

The mean results of these experiments showed that any current, travelling at a rate of 7 feet per second or more, might be dangerous, and that usually the Davy lamp allowed the flame to pass the most readily, the Clanny next, and the Stephenson last. The Mueseler is about as safe as the Clanny.

In 1868, a Royal Commission was appointed in Belgium to investigate and report upon the relative safety of the various lamps in use. This Commission carried out a number of experiments, and continued its work down to 1876, when the report was issued. Following upon the same lines as the English Committee, the Belgian Commission examined carefully into the subject of the velocity required to pass the flame through the gauze of the various lamps. In these experiments, the lowest velocity which produced this effect was 6 feet per second, the highest required being 18 feet. Coal gas was used mostly for the purposes of this investigation, which is rather to be regretted, although there were difficulties in the way of making the experiments with the fire-damp. It was found that oil and coal dust on the gauze of the lamp increased the risk of communicating explosion; also that under some circumstances the swinging of a lamp in an explosive atmosphere was attended with danger.

The conclusion at which the Commissioners arrived was, that the Mueseler lamp was the best and most satisfactory lamp examined (and the number dealt with was large); and this result led to the compulsory adoption of this form of safety lamp, of a definite pattern, in all the Belgian pits in which protected lamps have to be used. Appended to the Royal decree enforcing this, there is a good and useful code of articles, which, as they may not be generally known, are here stated. The translation is by Mr. A. H. Jones, one of her Majesty's Inspectors of coal mines:—

Art 1.—The employment of the Mueseler type lamps, fed with vegetable oil (*alimentée à l'huile végétale*), conformable to drawing, is obligatory for the lighting of fiery mines.

Art. 2.—Any other method, or mode, of lighting cannot be allowed without the previous authorisation of our Minister of Public Works, save the following exceptions.

a. The agents engaged for the superintendence of work, and who are not employed as workers, may make use of the Mueseler-Godin lamp, which consists of a glass interior simply supported upon an appendice not isolated.

b. For the fixed lighting of shafts, and for hanging on where the pure air comes direct from the surface, the mining engineers may allow the employment of the Mueseler lamp of a larger size than the type fed with vegetable oil (*alimentée par l'huile végétale*).

c. The chief engineers of mines may, in particular case, and by provisional right, permit the chief miners, deputies, and overmen only the use of the *Porion* (deputy) lamp, of the ordinary dimensions, and manufactured with a double gauze of 225 mesh, at least, per square centimetre.

The metal thread must have a quarter of a millimetre diameter, minimum size (No. 32 English gauge).

Art 3.—The safety lamps must be shut, locked, and remain deposited in the lamp cabin. Special agents should see that each lamp is conformable to the authorised type allowed by the administration of mines; they are further charged to see that the lamps are made clean, and maintained in good order by experienced workmen.

Art 4.—At the time of descending the lamp is given to each workman, who must assure himself that it is locked.

Art 5.—The lamps which happen to go out in the mine must be sent either to the surface, or to a place in the mine, where they shall be examined, re-opened, lighted, and locked by a man exclusively appointed for that purpose, acting under the supervision and the direction of the manager and deputies.

The places, or stations, where the lamps ought to be re-lighted shall be fixed by the order of the chief engineers, or the principal engineer, by means of notifying such stations upon the register of standing orders of the mine, in accordance with Article 24 of the regulations of March 1st, 1850.

Art. 6.—It is strictly forbidden to open the lamps elsewhere than in the places in the mines specified by the management.

Art. 7.—Every workman carrying a lamp which is not locked, or any instrument whatever by means of which his lamp can be opened, is immediately to be given in charge to special constables duly sworn in, whether it be to the officers of the mine, or to the local police, in order that legal action may be taken against him.

Art. 8.—It is forbidden to smoke in the mine. All miners carrying a pipe, or a steel for a tinder box, or a match, or any means for procuring a light, shall be given in charge, as in the previous Article.

Art. 9.—The designation of what constitutes a fiery mine shall be settled by the same means as is set forth in Article 5.

Art. 10.—When fire-damp appears in a working face, or in a heading, in sufficient quantity to cause a sustained elongation of the flame in the lamp, the work in such place shall be suspended immediately, and until such danger has ceased.

Art. 11.—Appeals to which the orders of the present decree may give rise, as well as demands for delay in their entire execution, should be addressed to the Permanent Deputation of the Provincial Council, which will legislate on their object, after having taken the advice of the Chief Engineer of Mines.

Appeals against the decision of this tribunal, either on the part of the engineers of the State, or on the part of employers, should be addressed to the Minister of Public Works.

Art. 12.—A type lamp of each of the systems allowed or tolerated, is deposited in the Department of Public Works, also in each district of mines.

In that which concerns the dimensions and the form of the essential parts of the lamp, the instructions annexed to the present decree must be complied with.

A convenient number of instruments for counting the number of wires and of gauges, for the purpose of verifying the metallic gauzes, will also be placed at the disposal of the officers of mines.

Art. 13.—Violations of the rules of the present decree are to be prosecuted, witnessed, and judged conformable to page X of the law of 24th April, 1810, upon the mines, mining works, and quarries.

Art. 14.—The present regulations shall be by the order of the directors and proprietors of fiery mines, affixed in a place accessible to the workmen.

Art. 15.—The regulations relative to the lighting of mines contained in the royal decree before quoted are hereby repealed.

The last cause of danger to be referred to, to which lamps are liable, is the sudden impact of an air or sound wave as opposed to a continuous current, although productive of the same effect. Mr. W. Galloway, whose name I have already had occasion to mention, and who has perhaps done as much during the last few years for the advancement of our knowledge in matters connected with coal mine explosions as anyone, has investigated the effect of these sudden air waves upon a safety lamp, especially in connection with blasting operations, the remarks concerning which will come more appropriately when dealing with that part of the subject.

Summing up what has been said regarding the use of safety lamps, the following are the conclusions:—That no lamp can be considered safe under all conditions; every form of lamp requires intelligent and careful use; nearly all accidents occurring directly from lamps are preventible; and finally, it ought to be accepted and insisted upon that the safety of a mine should never be allowed to be dependent upon the safety lamps.

Effects Produced by Alterations of Pressure and Temperature.

The effects produced by such changes upon the volume, motion, and accumulation of gaseous matter, are, in connection with the occurrence of fire-damp in mines, very important.

The normal pressure of the atmosphere upon every square inch of the earth's surface is 15 lbs., and this is equivalent to a barometric reading of 30 in.; an alteration, consequently, of an inch in the height of the barometer indicates an alteration of $\frac{1}{2}$ lb. pressure upon each square inch of surface. According to Boyle's and Marriott's law, the volume of a gas varies inversely as the pressure; if the pressure be doubled, the volume is reduced to one-half, and *vice versâ*. As the mobility of gases permits their rapid change of volume, the effect of an alteration of pressure becomes at once evident. An alteration of temperature also affects the volume of a gas, and, consequently, its density, a rise of temperature causing an expansion. The amount of this alteration is fixed and definite, being $\frac{1}{490}$ increase or decrease for each degree Fahrenheit up or down. These two results (pressure and temperature), either singly or together,

cannot fail to have an important bearing upon the issue of fire-damp into a pit and upon the ventilation generally.

The rate at which fire-damp issues into a mine from fissures and cavities is dependent mainly upon the difference in the pressure upon the gas confined in such spaces, and the pressure in the galleries of the mine, the gas flows into the pit tending to establish an equilibrum of pressure, if the pressure within the mine be decreased, the rate of flow will be increased, and *vice versa*; it does not follow that the whole effect of the alteration will be evident immediately, as, if fissures extend over some considerable area and communicate with large reservoirs of gas, it will take a larger or shorter interval before the rate of the flow of the gas into the pit once more adjusts itself to the changed pressure. The issue of gas from the exposed coal face, and from the excavated coal, is influenced in the same way, but the effect in this case may be looked for more speedily upon a change of pressure than in the other.

The natural ventilation of a mine depends upon the difference in density of the air within the mine, and that on the surface of the earth; the air below the surface is warmer than that above, and consequently posesses a less density. A shaft being opened into a mine, the lower air being light, will seek to ascend, while the upper air being heavier, will tend to descend; if no means be taken to divide these two currents they will neutralise each other, but if a second shaft be opened, or a single shaft be divided into two separate channels, and an artificial draught be started upwards through one of these, then a continuous current can be maintained up the one shaft and down the other, dependent entirely upon the difference in the two densities, the greater the difference in density the more rapid will be the current. Now, the greatest difference in density will occur when there is the greatest difference in temperature, the most rapid current being produced when the temperature at the surface is lowest and the temperature below ground the highest; the temperature in a mine is tolerably constant, so that the rise and fall of the temperature above ground will be the variable element. The natural ventilation of coal mines is most successful in winter. It has already been shown that the safety or danger of a mine in which inflammable gas occurs depends upon the rate at which the fire-damp issues into such a mine, and the rate at which such fire-damp is carried away by the ventilating current; hence it will be seen that the variations of pressure and temperature must be expected to have a very important influence on explosions taking place in mines. The subject has received considerable attention, and a mass of evidence has been placed on record; it is in reality by the accumulation of such evidence that some successful generalisations are to be expected, for it is only by observing a number of facts that the elements of uncertainty (arising from a number of special circumstances) can be eliminated.

The first important publication on the subject is a paper by T. Dobson, published in the report of the British Association for 1855, the title being, "On the Relation between Explosions in Coal Mines and Revolving Storms." This paper contains the records of a number of great storms or cyclones, together with the known explosions which took place at about the same time. The examination of these statements shows a general connection between the meteorological disturbance accompanying a storm, and the accidents from fire-damp occurring in a mine; one remarkable instance is mentioned. A great storm occurred in England on the 4th of October, 1846. During the previous four months no accidents from explosions are recorded, but within 11 days, near the above date, five fatal explosions took place, viz.. on September 26th, 28th; October 1st, 3rd, and 6th, and after this no explosion in the English coal pits is said to have taken place for six weeks. Mr. Dobson has taken all the recorded explosions happening up to 1854, which number 514, and has plotted them in the form of a curve, which is proved to have a certain correspondence with the curves representing the changes of the barometer and thermometer. Further, 491 of these explosions, being those for which the day of occurrence is known, are arranged in 73 periods of five days each, and from the result, Mr. Dobson concluded that explosions take place with a certain amount of periodicity, being more frequent during the autumn and winter months than at the other seasons of the year. Little information was added to this knowledge until Messrs. Scott (the Director of the Meteorological-office) and Galloway continued the investigation. Their first paper was published in 1872, in the "Proceedings of the Royal Society," vol. xx., p. 292; in this paper the general influence of a depression of the barometer or a rise of temperature is maintained, but the supposed periodicity of Mr. Dobson is disproved, for Messrs. Scott and Galloway took the whole of the explosions occurring for 20 years, numbering 1,369—these were all represented by intervals of five days in two periods of 10 years—the result showed that there was little or no difference in different seasons of the year; the absolute maximum fell at the end of January, and the minimum at the middle of September. The meteorological observations used for comparison were made at Stonyhurst. A difficulty occurs in respect of any such curves owing to the important influence which the partial or total suspension of work in a mine on Sundays exerts. Explosions do not happen only at the commencement of a barometric depression, but frequently two or three days afterwards; the limit is placed in this paper at three days; the reason of this is obvious. The gas begins to be influenced at once by such a depression, but its effect upon the atmosphere of the mine is a gradual one, and it is pointed out that an oscillating barometer within comparatively narrow limits, may have eventually the same effect as a sudden and considerable depression. Spaces and cavities and even the ventilating current may be considerably fouled with fire-damp before any alteration of temperature or pressure takes place, and the effect of such changes may be to cause the issue of such an amount of gas as shall produce a dangerous result. A careful watch is advised to be kept upon the state of a mine, when either a fall of barometer or a rise of thermometer or both together takes place. A second and a third paper by these gentlemen appeared in October, 1873, and October, 1874, continuing the observations and tabulating the results in a convenient form. The following exhibits the general results:—

Year.	Total number of explosions.	Per-centage due to		
		Barometer.	Thermometer.	Neither.
1868-70	550	49	22	29
1871	207	55	12	26
1872	233	58	17	25

On December 20th, 1871, a sudden storm occurred, with which five accidents are associated.

The following practical observations are made in these papers:

1st. If the barometric curve, after having remained about the same height for several days, descends half an inch, or an inch, during the next two or three days, fire-damp may be expected in greater quantity than usual in cavities in the roof, and in the higher parts of the working, both during the descent of the curve and for a day or two after it has reached its lower limit; under these circumstances fire-damp may also be expected to appear in some places in which it had not been seen before.

2nd. As the curve of temperature rises to 55° and upwards, the ventilating power should be increased at the same time; and the higher the temperature, the greater is the necessity for such increase in order to prevent a possible stagnation of the ventilating current.

3rd. If a sudden fall of the barometer takes place (an inch in twenty-four hours or so) or a further fall after it has been unusually low for a day or two, the utmost care will be necessary to guard against explosions, and more especially if this phenomena be accompanied by a rise of temperature.

The average number of annual explosions involvthe loss of more than 10 lives, has been for the last 20 years, three. The Mines Regulation Act requires that "After dangerous gas has been found in any mine, a barometer and thermometer shall be placed in a conspicuous position near the entrance of the mine;" it is not, however, necessary that separate meteorological observations shall be made for each mine, one station at which such observations are made being sufficient for those mines within a distance of 100 miles. It was considered at one time that the direction of the wind exerted some influence, but these later investigations have proved that such is not the case. Great complaint is made by Mr. Galloway of the very imperfect, and sometimes culpably faulty, reports, which are required by law to be made regarding the occurrence of fire-damp in mines. The firemen upon whom the duty falls ought to be steadily conscientious in this matter, and it should be the care of those in authority to see that, as far as possible, such is the case. Finally, it may be again stated that no naked light should be used in a mine in which fire-damp exists, or in unventilated spaces, especially on a fall of the barometer taking place.

Blasting Operations.

Operations of this nature are frequently employed, either to obtain the coal itself, or for the purpose of removing obstacles to the ready working of the coal. The coal is sometimes removed by loosening or cutting the sides all round, and then introducing a charge of powder behind the block, which, on its explosion, brings down the mass of coal. Rocky or hard ground is usually broken up by the use of powder. The method of conducting the blasting operation is very much the same as that employed elsewhere; a hole is drilled of a sufficient depth, into this a charge of powder or other explosive in the form of a cartridge is introduced, the drill hole is then filled up with tamping, which is rammed in tightly, and, by means of a slow fuze, the charge is ignited. In mines quite free from fire-damp, this operation is not attended with special danger, but, unfortunately, it is too common to employ blasting in mines which are by no means free from inflammable gas. In these cases it is usual for an examination of the neighbourhood to be made with a safety lamp, in order to detect the presence of gas. The shots also are only allowed to be fired by responsible persons, appointed for the duty.

There are two direct and obvious dangers arising from the employment of blasting in mines. 1st. The possible ignition of gas, which is present in the mine at the time of firing, by the flame of the explosion itself, occasionally by the blowing out of the shot. 2nd. The concussion of the explosion may liberate a quantity of gas, which escapes into the mine, and is afterwards ignited at some open light. In addition to these direct dangers, there are other indirect ones, such as the risk, which must always accompany the presence of gunpowder at all in the mine; and, again, the amount of latitude which is allowed to those in charge of the blasting operations, frequently leads to carelessness. It has been attempted in the last Mines Regulation Act to surround the use of powder with so many precautions as to reduce the risk to a minimum. No powder is allowed to be stored in the mine, and no quantity greater than four pounds shall be in the charge of a workman at one time. The powder must, before being taken into the mine, be made up into cartridges, and these must be contained in a case or canister. If any fire-damp has been observed in the pit during the previous three months, the mine in the neighbourhood is required to be examined for fire-damp before the blast is fired; if any fire-damp is observed which causes a blue cap in the flame of the safety lamp no blasting shall be permitted. Unfortunately here, as in the case of the use of the safety lamp, miners appear in many cases to ignore the rules and regulations made entirely in the interest of their own safety, and to become careless and negligent to a degree. It is admitted that the above rules frequently become a dead letter, and their observance neglected. An illustration of this occurs in the case of the terrible explosion at Blantyre on 22nd October last. The following is an extract from the report of Commissioners appointed to investigate the matter, and which has just been presented to Parliament:—"Powder required to be in a case or canister was allowed to be taken into the mine at times in paper parcels. Powder, where inflammable gas had been met with during the preceding three months, was allowed to be taken in paper parcels or canisters, loose, instead of in the required cartridges. The special rules made each fireman the 'competent

person' to supervise the firing of shots where gas had been met with during the preceding three months, but the miners fired their own shots, except at the stoopings, without supervision. Shots, disavowed by the manager as being unsafe near accumulated gas at the stoopings, were fired with an open light by the special fireman." It is stated also, in another place in the report, that two or three days before the explosion blasting shots were fired in places in the mine in which there existed at the time a quantity of gas; one of the firemen fired the shots, opening his safety lamp to do so, and the expression is used that he did so "watching a chance." The fearful import of this state of things is seen when it is remembered that within three days afterwards 209 persons were killed in that pit.

Seeing that this, in all probability, although it is to be hoped an exceptional case, is not without its parallel, it has become a serious question whether blasting operations should not be prohibited entirely in coal mines; the loss of a useful agent would be felt, but a considerable increase of safety would ensue; before, however, this is done, pressure should be put upon all persons concerned to see that the necessary rules are strictly carried out.

A third indirect danger from shot firing arises from the fact that the flame of a safety lamp may be blown through the gauze by a condensed air or sound wave, which result may occur at a considerable distance from the point of original impulse. This subject forms another of those which have been investigated by Mr. Galloway.

Many accidents have occurred which have been wholly unaccounted for. Many of them have taken place immediately following the firing of a shot, especially if the shot be a blown out one. The neighbourhood of the place has been found free from fire-damp, and after the explosion it has sometimes happened that all the safety lamps have been found locked and secure; occasionally two explosions, one immediately following the other, in different parts of a mine, have occurred. A notable case of the coincidence of firing of a shot and an explosion was recorded in the great disaster at the Oaks Colliery, in 1866, when 334 persons lost their lives. This connection between shot firing and explosions is partly traced by Mr. Galloway to the above fact, and a number of experiments tend to prove this to be the case. If an ordinary safety lamp, surrounded with an inflammable mixture, be placed at the end of a long tube, divided in its centre by some flexible diaphragm, such as india-rubber or paper, on an explosion being artificially produced at the further end of the tube, it will be found that the flame burning within the lamp will be driven through the gauze, and communicate the combustion to the outer mixture. A pistol-shot, or the explosion of soap bubbles filled with a mixture of oxygen and hydrogen, may be used. In such a case, no material substance passes to the flame of the lamp from the source of the explosion, seeing that the tube is divided by a diaphragm; an air or sound wave starts from this membrane, however, and passes to the lamp with the above effect. These experiments were repeated on a larger scale in a brick sewer 109 feet long, the same effects being observed. A lamp arranged as before being placed at one end, and a pistol fired at the other (even if directed towards the roof), the flame was found to pass through the gauze. From such a sewer it is not difficult to pass by analogy to the gallery of a mine, and to see that the firing of a blasting shot may set up a sound wave which shall travel to some distance. Near the place where the shot is fired there may be no fire-damp, but at some other spot reached by the air wave a safety lamp may be burning in a dangerous atmosphere, and an accident may result. I have repeated many of these experiments of Mr. Galloway, and it would appear that the suddenness or intensity of the wave has much more importance than its volume. Such an initial impulse as a pistol-shot I find is by no means required. The following experiment was made:—A tin funnel, with a neck of about 1½-inch diameter, has a piece of sheet india-rubber stretched on its larger end (such a funnel is frequently used for the production of smoke-rings); by suddenly tapping the india-rubber with the finger a puff of air is expelled from the funnel, and the puff of air, if directed against a flame protected by gauze, will drive it through the gauze, and may be readily made to ignite a combustible atmosphere on the outside. The volume of the air expelled is, in this case, very small. (Experiment made at the lecture.)

When speaking of the safety of miners' lamps, it was stated that a current travelling at the rate of from 7 to 8 ft. per second might, and sometimes does, hurry the flame through the gauze of the lamp. Many calculations have been made with a view to show that for such a current to exist enormous volumes of fire-damp must escape into the ventilating current, and the conclusion has been drawn that such a state of things rarely, if ever exists, and that therefore an explosion from the passage of the flame through the gauze is almost impossible. In view of the above experiments, however, such conclusions may be fallacious, seeing that no continuous current is at all necessary, a mere puff, if sufficiently sudden, of air or gas being sufficient to produce the result. A calculation of this nature is the following, by an experienced mining engineer:—

"If we take an ordinary working head, having a sectional area of (say) 30 ft., or 6 ft. by 5 ft.—something like an average area—and we have (say) 6,000 cubic feet of air passing per minute, it is required that about 700 ft. of gas per minute be generated to produce an inflammable current, but as the speed is only 3·33 ft. per second, the conditions of danger are not present. Where, then, or when in a mine is it likely that those conditions are to arise? It will require an immense quantity of air and a great discharge of gas to produce those conditions. Taking an ordinary working head as before, we will require a speed of 8 ft. per second, or 14,400 cubic feet of air per minute, and a discharge of gas equal to nearly 2,000 ft. per minute, and those circumstances are not at all likely to occur. They have very rarely occurred—of that we may be assured, for we must not lose sight of the fact that the condition necessary to produce an explosion must be pretty closely fulfilled, otherwise there will be no explosion."

Recently, in connection with blasting, a new suggestion as to the immediate cause of some explosions, and the aggravation of others, has been made. This is the possible influence which the presence of a quantity of dry and fine coal dust may have in increasing the explosiveness of some atmospheres. Coal mines are dry or wet,

according to the nature of the superincumbent strata. The floor of dry mines is usually covered with a considerable layer of very fine coal dust, and the air of such mines is more or less loaded with the same dust, the fineness of which is remarkable. If, after working in a coal mine for some time, the skin is freely washed with soap and water two or three times, and is then examined with a magnifying lens, particles of coal are still seen filling up its pores. The most severe explosions usually take place in dry mines.

The suggestion is, that this coal dust, if stirred up and mixed with the air of the mine by the firing of a shot, may produce in this way an explosive atmosphere. An observation made by Faraday and Lyell, in 1845, when examining into the cause of an explosion in a coal mine, bears upon this subject. They found that upon the sides of the props and supports facing the direction in which the explosion had travelled, there was a quantity of coal dust which presented the appearance of having been partially burnt or caked, and they suggested that this coal dust took some part in the explosion. The first important contribution upon this subject is to be found in a paper, by M. Vital, in the "Annales des Mines," for 1875. This gentleman investigated an explosion which took place in France in November, 1874. A blown out shot immediately preceded, or was the cause of the explosion; this shot was fired at the level of the floor. No fire-damp had ever been observed in the pit before, yet a serious explosion took place, the mine was dry, and the floor was covered with a layer of very fine coal dust. M. Vital conceived that the only explanation was the formation of an explosive atmosphere by the volume of dust raised by the explosion, and following up this idea, he made a number of experiments to determine the conditions of the matter. His conclusion was that the presence of large quantities of dry coal dust in a mine is a serious element of danger, and that without the presence of any fire-damp, this dust if mixed with air may form an explosive mixture. As a parallel case, the occasional explosions which occur in flour mills may be cited; fine flour dust and air may produce a mixture, which, if not explosive in the ordinary sense, becomes inflammable throughout its whole volume. Mr. Galloway has carried M. Vital's experiments further with more remarkable results. No exception can be taken to Mr. Galloway's experiments, as they were made with absolute pit gas and the coal dust occuring in the mine. For the details of the apparatus employed, reference must be made to the Proceedings of the Royal Society, No. 168, 1876. The conclusions were as follows:—

1st. A mixture of air and coal dust is not inflammable at ordinary pressure and temperature. (Difference from M. Vital.)

2nd. The admixture of a small amount of fire-damp makes such a mixture inflammable; ·892 per cent. of marsh gas is sufficient for the purpose, while the proportion of marsh gas required to form an explosive mixture with air alone is at least 6 or 7 per cent. (Experimentally illustrated at the lecture.)

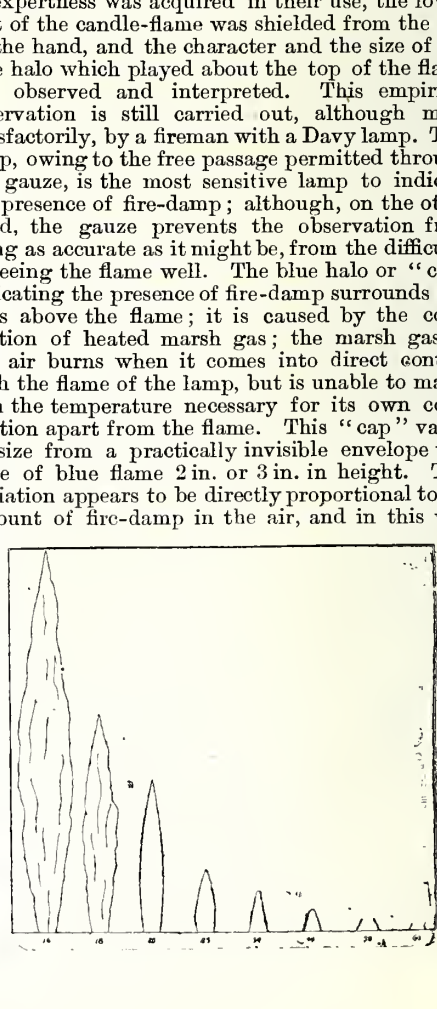
Now a safety lamp (the ordinary means used) gives positively no information of the presence of gas in any quantity less than 1 part in 60 of air, yet 1 part in 112 of air, together with coal dust, is sufficient to produce an explosive mixture; hence an accident may take place in a mine which is usually considered to be quite free from fire-damp.

Evidence of the influence of coal dust will be looked for in future explosions, and will probably prove the truth of these important facts. In an explosion which took place at the Llan Colliery, South Wales, which was investigated by Mr. Galloway, evidence was given that the presence of coal dust aggravated very considerably the extent of the accident.

Explosions of fire-damp and coal dust are not of such great violence as those of fire-damp and air, but are likely to extend over larger areas. The means for the prevention of such accidents would be the removal of the coal dust to prevent its accumulation, or the constant watering of the roads.

ESTIMATION OF FIRE-DAMP IN MINES.

Frequent mention has been made in these lectures of the influence which the pressure of marsh gas has upon the appearance of a candle or lamp flame burning in such an atmosphere. Before the days of safety lamps, the miners used to employ their candles for the examination of the air, and in the hands of an experienced man a large amount of expertness was acquired in their use, the lower part of the candle-flame was shielded from the eye by the hand, and the character and the size of the blue halo which played about the top of the flame was observed and interpreted. This empirical observation is still carried out, although more satisfactorily, by a fireman with a Davy lamp. This lamp, owing to the free passage permitted through the gauze, is the most sensitive lamp to indicate the presence of fire-damp; although, on the other hand, the gauze prevents the observation from being as accurate as it might be, from the difficulty of seeing the flame well. The blue halo or "cap" indicating the presence of fire-damp surrounds and rises above the flame; it is caused by the combustion of heated marsh gas; the marsh gas in the air burns when it comes into direct contact with the flame of the lamp, but is unable to maintain the temperature necessary for its own combustion apart from the flame. This "cap" varies in size from a practically invisible envelope to a cone of blue flame 2 in. or 3 in. in height. This variation appears to be directly proportional to the amount of fire-damp in the air, and in this way



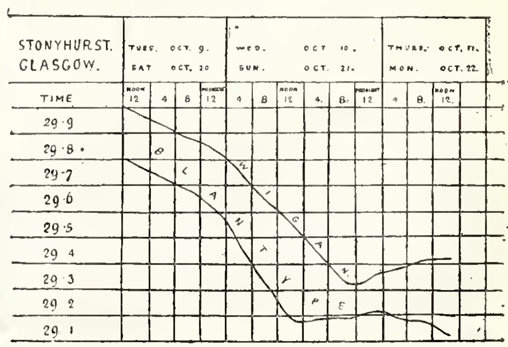
the height of the "cap" can become a measure of the fire-damp. Mr. Galloway has been able to reduce this to something like definiteness by actual measurements of the "caps," obtained by introducing lamps into atmospheres containing known proportions of fire-damp. The sketch on the preceding page is from these results, and it exhibits the character and relative size of the "caps," obtained with varying quantities of fire-damp. The figures at the base of each "cap" indicate the number of volumes of air mixed with one volume of fire-damp. The actual height of the largest "cap" represented is 3⅝ in.

The lamp best suited for observing these "caps" is the ordinary Clanny, the glass base enabling the smaller "caps" to be seen with more distinctness. The flame of the lamp should be drawn down until it is almost extinguished, leaving a small point of blue light about one-eighth of an inch high, with a faint trace of yellow in the centre. Two Clanny lamps properly trimmed give very concordant results; no gas below the proportion of 1 part in 60 can be distinguished by these caps. The paper by Mr. Galloway containing the details of the experiments will be found in the Proceedings of the Royal Society, No. 168, 1876. In the hands of intelligent men interested in these matters, a knowledge of these facts ought to be of considerable value, and for the examination of the amount of fire-damp in the return ventilating current they should be useful to the officials.

Since the commencement of these lectures, two very serious and deplorable explosions have occurred in British coal-pits, resulting in the loss of a large number of lives; the first took place at Pendleton, near Wigan, on the 11th of October, 1877, in which 30 or 40 persons were killed, and the second and more serious one at Blantyre, near Glasgow; this accident happened on the morning of October 22nd, and is the worst accident of which there is any record taking place in Scotland, 209 persons having lost their lives. The official report of the investigation of this accident, which was held shortly after the occurrence, has just been issued, and I have already referred to it in connection with a previous matter. There are one or two other points, however, upon which I should like to speak. The report, on the whole, cannot, I think, be considered a satisfactory one, the immediate cause of the accident is still left in doubt, although in the face of the extraordinary revelations of carelessness and negligence which were made, the wonder is that an explosion did not take place before it actually occurred. The report leaves unreferred to, or inadaquately referred to, some important matters; this, no doubt, is largely explainable by the fact that those who would have been the principal witnesses were destroyed by the explosion. No precise evidence was obtained, so far as I can see, as to the state of the ventilation of the pit on the preceding day (Sunday), or whether anyone was in the mine between Saturday night and Sunday morning. One coal master gave evidence that the ordinary issue of fire-damp into the pit was such that, in his opinion, an interruption of the air current during about four hours might have sufficed for the explosion; and the opinion of a second was that it would not have required many minutes to produce the same result. No stress is laid upon the fact that it was a dry mine, or upon the possible influence which the presence of coal dust may have had.

The evidence showed that the whole system of discipline was loose, and certain to lead to bad results. Regarding the discipline, the Commissioners use a remarkable phrase, stating that it was of a "mixed" kind. Accumulated fire-damp had been found shortly before the explosion, and although this was the case, blasting operations were still carried on; it seems probable, indeed, that a blasting shot was the direct cause of the accident; in some places, where fire-damp had been found shortly before, blasting was said to have been prohibited by the manager, but was still in use. Evidence was taken at the investigation, respecting the variations of the barometer and thermometer at the time, but it would appear that this evidence did not cover a sufficient period of time. Readings of the barometer at Kew, at Derby, at Manchester, and at Glasgow were presented, the latter obviously, being as it is within a few miles of the spot, the most important. At Glasgow, it is stated that the barometer varied only 0·120 of an inch during the 24 hours preceding the explosion, the variations in the height having been between 29·264 and 29·144 inches, the fall between 8 o'clock and 9 o'clock, a.m. of October 22nd (the explosion being at 8·45, a.m.) being only 0·022 of an inch, which, as it is said, no colliery manager would think worthy of notice; but a further knowledge of the state of the barometer, throws rather a different light on the matter. When dealing with the subject of the influence of an alteration of pressure, it was stated that its immediate effect was not felt, but that a period of about three days must be taken, over which its influence might be taken. Now, although the above figures are accurate, the range of the barometer quoted is for too short a period, as, if the readings for the previous 38 hours are taken, instead of 24, it will be seen that a by no means inappreciable fall took place. At 12 o'clock noon of Saturday, October 20th, the barometer at the Glasgow Observatory, according to the official record, stood at 29·79 inches, from this point it immediately began to descend, and continued to do so until 12 o'clock noon of Sunday, the 21st, when the height was 29·18, or a fall of ·6 of an inch; from this point it remained steady until after the time of the explosion, 8·45 a.m., October 22nd. This fall, however, was not referred to at the investigation. I have shown the barometer readings in the form of curves in the following diagram for both the explosions at Wigan and Blantyre. The

BAROMETRIC – READINGS – 1877.



readings were made respectively at the Glasgow and Stonyhurst Observatories.

It is right to say here that the times are placed rather close together, hence the steepness of the curves is somewhat exaggerated. A fall of ·6 of an inch in 24 hours is not an unusual occurrence; at the same time, when looked at with respect to the state of things existing at the Blantyre Pit, it probably had an important influence. The Wigan accident took place on Thursday, the 11th of October, and here, again, during the two previous days there had been a continuous fall, from 29·97 to 29·34, the barometer having again commenced to ascend slightly when the explosion occurred.

Conclusion.

In bringing these lectures to an end, let me say that there is, at the present time, a large amount of information in existence, and more is being continually accumulated, regarding the causes of, and the circumstances connected with, explosions in coal mines, and it becomes necessary and imperative that colliery proprietors, managers, and engineers should be so acquainted with what has been placed on record, both in England and on the Continent. as to carry on the work of mining under those conditions which give the minimum amount of risk.

The great body of the miners, including the subordinate officials, require to be educated in the matter of their daily work, that they may spontaneously avoid danger, and appreciate the responsibility under which they are acting; this would largely place them in a position above the mere necessity to act ignorantly under, and frequently culpably to ignore, stringent bye-laws. If a miner understood fairly the nature of safety lamps and their possible dangers, it is hardly conceivable that he would require a lock to prevent his tampering with it, although such a safeguard may be at all times a necessary precaution.

And, lastly, the public should insist that under all circumstances the restrictions and directions imposed by the Legislature are faithfully observed.

I have to express my thanks to Mr. W. Galloway, of Cardiff, one of H.M. Inspectors of Coal Mines, for much information which he has kndly furnished me, also to Mr. R. Scott, the Director of the Meteorological-office, and to Mr. W. E. Teale, to whom I am indebted for a number of specimens of lamps, old and new, which have been exhibited.

MISCELLANEOUS.

NATIONAL CULTIVATION OF MUSIC.

At a meeting of the Clergy, held on the 30th of January, 1878, at Manchester, at which the Bishop of Manchester presided, a committee was formed, for the purpose of securing more efficient instruction in music in Elementary Schools, and promoting the training of teachers. In accordance with the request of the committee, the Rev. Dr. Burton, Rector of All Saints', Chorlton-on-Medlock, Manchester, and the Rev. E. Preston Anderson, Curate of S. Gabriel's, Hulme, and Precentor of the Manchester Gregorian Choral Association, submitted for approval the following graduated system, and it was ordered to be printed for general consideration:—

Suggested Musical Grades for Elementary Schools.

Grade I.—*Vocal Music by Ear*, as taught at present for the Government grant of one shilling per head.

Grade II.—*Musical Nomenclature*, viz., the use of the Staff or Stave, Treble and Bass Cleffs, Sharps, Flats, and Naturals; and forms of Notes, Rests, and Bar lines.

Grade III.—*Scales*, Major and Minor in the open key. The Dot, Accidentals, different kinds of Time, together with a knowledge of the following marks of expression: —*ff*, *f*, *mf*, *pp*, *mp*, *p*, *crescendo*, *diminuendo*, *sf*, $<$, $>$, $<>$, and *Rall.*

Grade IV.—*Intervals.*—To sing a simple melody in the open key; to understand such words as:—*Grave, Adagio, Largo, Allegro, Andante, Moderato, Presto, Tempo.*

Grade V.—The Scales of G, D, F, and B Flat, Major, with their relative Minors. To sing simple melodies in these keys; and a knowledge of the following forms, viz., Chant, Hymn Tune, CM., LM., and SM.; and the meaning of the words Solo, Duett, Trio, Quartett, Chorus, Melody, and Harmony.

Grade VI.—The keys of E Flat, A Flat, A and E Major, and their relative Minors. To sing simple melody in any key. To understand the meaning of the words Anthem, Sanctus, Oratorio, Opera, Glee, Part-song, Madrigal, &c., together with the names of some principal composers in each department.

PARIS EXHIBITION.

[FROM A CORRESPONDENT.]

It is unnecessary for me to speak in general terms of the opening of the Exhibition, as the daily papers will do that, but a few remarks on the technical and artistic sections may be acceptable.

In the first place the Chinese court was the only one that was complete on the opening day, and the fact should be recorded in their favour. The space occupied is considerable; the glazed cases were filled with the most exquisite fabrics, and the open stands with a grand collection of furniture and porcelain, all admirably arranged, and guarded by some twenty attendants in their native costumes, who seemed as much at home as if they had been engaged in international exhibitions all their life. The floor of the court had not only been swept, but washed, and the air of repose was as comfortable as if the place had been an old-established museum, but without the musty smell.

The Japanese court adjoining was not complete, but all the front cases were well filled, the collection of porcelain being grand and of the highest class.

These two fine courts form a museum of Oriental art which every student should visit if possible; almost every branch of applied art is there illustrated, and the textiles are crisp with beauty; for texture, colour, and, in many respects, for design, they may challenge the world.

But besides the contents of the Chinese cases, the latter demand a few words; no such splendid setting has ever been attempted before for an exhibition, and the execution is as admirable as the designs. The cases are all designed somewhat in the style of temples, with roof and pillars, and every part is decorated with great skill; fine natural woods are used in the construction, and the whole surface is covered with the most elaborate and ingenious carving, and pierced, generally in low relief, while in other cases the figures stand out prominently from the surface, and are brilliant with vermillion and gold. The Japanese cases are generally plain, but they also have some examples of their decorative art in the form of illuminated windows and carved work of a character quite distinct from that of the Chinese.

There are innumerable objects in each of these courts which deserve special notice, but what I have said above must suffice for the moment. I should add that the courts in question form but a portion of the Chinese and Japanese exhibition, the Commissions having erected several buildings on the Trocadéro, on the other side of the river, where their modes of construction, and their unrivalled lacquer work, are admirably illustrated.

It is admitted on all hands that the British Industrial Sections are nearer completion than those of any other nation, and the most complete classes are those of glass and keramic ware; in the latter I did not miss yesterday a single eminent firm, and the collections are large, choice, and well shown, calling forth expressions of unqualified approbation from those of our friends here who are best authorised to speak upon such matters. The progress achieved since the last grand exhibition was held on the same spot, 1867, is pronounced to be very decided.

The English mediæval metal and other work is admirably represented, and cutlery attracted great attention, as did also Messrs. Elkington's grand court with its handsome golden gates.

Canada and the other English colonies deserve a passing word. Their courts are generally well filled and in good order, and the series of cases formed of fine Canadian woods have attracted much attention.

In the grand vestibule, through which the procession passed yesterday, H.R.H. the Prince of Wales's Indian collection is prominent; a handsome carved oak cabinet, designed and executed in a few days, filled with a selection of some of the most beautiful objects, attracted universal attention. Opposite to this cabinet, on the other side of the principal door, the French State jewels were to be exhibited, but for some unknown reason their place was vacant. In the rear of the Indian collection stands the Indian temple, which contains magnificent specimens of Oriental fabrics; one of the pavilions being almost entirely occupied by the numerous and choice contributions of Messrs. Vincent, Robinson, and Co., of Wigmore-street, London—carpets, divans, a tent cover, shawls and other delicate fabrics, old ware and other articles; but perhaps the most remarkable contribution of this firm, and one of the most curious in the whole exhibition, is a large carpet presented to a great Indian potentate three hundred years ago; the design is good, and the perfection of workmanship is unsurpassed. On the French side of the vestibule a large wooden structure has been set up, to balance the Indian and Colonial temple, and in this is a collection of choice specimens of Sèvres porcelain and of Gobelins and Beauvais tapestry. Beyond this again is a colossal bronze group of Charlemagne on horseback attended by two warriors, a very remarkable work on a grand architectural structure, by M. L. Rochet, who died before his model was cast in bronze.

Passing to the other extreme of the Exhibition to the vestibule of the Ecole Militaire, is a section which cannot fail to have a great attraction for many of your readers; this is the process court, which has already formed one of the most popular sections of several grand exhibitions. In 1867, on this same site, the process court occupied a portion of the machinery court, and was crowded daily to an inconvenient degree. The present process court occupies a gallery 1,300 feet long, and more than 80 feet broad; and, although the installations are yet incomplete, it has been crowded from the moment it was thrown open. Each exhibitor of a process has a space surrounded with a low but very solid oak wall, strong enough to resist any amount of pressure that a crowd could possibly exert upon it, and each is supplied with gas and steam if requisite. In one case, namely diamond cutting, a steam-engine is used. Besides diamond cutting, the processes illustrated include die sinking and medal striking; ivory working, essentially a simple manual art, but which seems to have a great attraction for many persons; fan making, in which the use of the hand fret saw is a novelty to most visitors; the making of hand bags and other leather work affords a good example of economical and rapid manipulation; the production of artificial flowers is always attractive, and two forms of this industry are illustrated, the production of ordinary flowers, in which both the stamping out of the parts and their manipulation are shown, and the making of glass, or rather of enamel flowers. Weaving is always attractive, especially when as in the present case, it consists of the production of Cashmere shawls by native workmen; another kind of weaving is also being arranged; by the side of the Indian weavers sit two women from one of the French provinces, whose language no Parisian can understand, playing, as it seems almost to the uninitiated, with a few hundred bobbins; the making of Leghorn hats is illustrated by means of sewing machines, and a powerful steam press to give shape to the hat; the jewellers and trinket makers' stalls naturally attract much attention; but hardly more so than the hair workers, who astonish the uninitiated by fixing single hairs into the framework of a wig with a kind of crochet needle. Each of these industries is illustrated by several persons, six, eight, or ten, a large proportion being women. Nothing can exceed the animation of this industrial vestibule.

Another feature of the Exhibition which achieved remarkable success from the first is what is called the facades, or the "street," the series of examples of the architecture of the foreign contributing nations. On the present occasion I shall confine myself to those of Great Britain, which are five in number, no other nation having more than one.

The principal of these is the pavilion of H.R.H. the Prince of Wales, an Elizabethan-house, on two floors, and five windows wide, designed by Mr. Gilbert Redgrave, representing a red brick structure faced with Bath stone. It contains a dining-room ornamented with black walnutwood work, and with tapestry from the Royal Windsor Works, comprising scenes from the "Merry Wives of Windsor," and a portrait of Her Majesty the Queen; a drawing-room after the manner of Adams, hung with brocaded satin and enriched with panels, the furniture being of citron and boxwood, carved; a smaller drawing-room in modern English style, fitted with rosewood, and decorated with panels of Japanese lacquer or ivory, and bedchambers in eighteenth century style, with inlaid furniture of mahogany and citron wood, and woodwork of solid walnut and oak. The interior decorations and the furniture are by Mons. Gillow and Co. Messrs. Barnard, Bishop, and Barnards have contributed some of their beautiful work in the form of the fire-places of the dining-room and railing outside; the fire-places of the drawing-rooms and reception-rooms are in cast steel, by Messrs. Feltham and Co.; the *carton pierre* decorations, in the drawing-room, by Messrs. Jackson and Graham; mosaic work and tiles by Messrs. Minton, Hollins, and Co.; the carpets and curtains by Messrs. Templeton and Co.; the embroidery in curtains and furniture by the Royal School of Art Needlework; embroidery applied to the walls and panels of the small drawing-room by the Ladies' Work Society; the windows and table glass by Messrs. Powell and Son; a conservatory by Radcliffe and Co.; a table service in *repoussé* silver, and a set of chimney ornaments by Messrs. Elkington and Co.; porcelain table service and vases by Messrs. Minton's, with a fountain in small court adjoining; another fountain is supplied by Messrs. Doveton and Co., from design by Mr. G. Tinworth; the table linen is from Mr. Andrews' establishment at Belfast; the sanitary arrangements by Mr. Jennings; and the matting by Messrs. Treloar and Sons.

The Prince's pavilion is flanked and relieved by two small terra-cotta houses. One of these was built by Mr. W. H. Lascelles, of London, from a design by Mr. R.

Norman Shaw, R.A. The mode of construction consists of slabs of red composition, the size of bricks, screwed on to wood framing, with a backing of slabs of Portland cement. The furniture in this little house is by Messrs. Jackson and Graham, and the paper-hangings by Messrs. Jeffrey and Co.

The house on the other side of the pavilion is in red brick and terra-cotta, by Messrs. Doulton and Co., after designs by Messrs. Tarring and Wilkinson, and attracts much attention; the decorations and furniture are by Messrs. Shoolbred.

The fourth "façade" is a specimen of the "half timber" structures of the fifteenth to the seventeenth centuries, and is constructed by Messrs. Cubitt and Co., from the design of Mr. Gilbert Redgrave. It is built of pitch pine, the panels which fill up the intervals of the timber being of plaster, and these panels are decorated by the insertion of carved wooden ornaments. The iron work is also by Messrs. Cubitt, from the designs of Mr. Barry, R.A., from Lord Crewe's park; the furniture is by Canadian manufacturers; the carpets from designs, I believe, of Dr. C. Dresser; and the paper-hangings by Messrs. Jeffrey and Co.

The last house is an example of an English country residence of the time of William the Third, from the design of Mr. T. E. Collcutt, the framing being of wood; the construction and furnishing of this excellent specimen of a little known epoch are entirely the work of Messrs. Collinson and Lock, of London.

The whole of these houses—not including, of course, the first—have been placed at the disposal of H.R.H. the Prince of Wales, who has devoted them to the use of the Canadian and other Commissions, and, I believe, of the British jurors.

Two structures by other contributing nations—namely, a timber house from the United States, constructed for transport; and an example of the wooden structures of Sweden and Norway—complete the portion of the street at the British end. Here commences the central garden, in which is the grand pavilion of the City of Paris, devoted to the exhibition of all the *matériel* of municipal works; and beyond the garden, again, are the "façades" of the rest of the contributing countries, but I must defer notice of these to another occasion.

THE WOOSUNG RAILWAY.

Consul Davenport, in his report upon the trade of Shanghai for the year 1876, furnishes a history and description of the working of the Woosung Railway. He states that foreigners resident in China have long been watching for an opportunity for the introduction of railways, and so long ago as June, 1863, application was made to the provincial authorities for permission to construct a line from Shanghai to Soochow. This permission being refused, nothing further was done until December, 1872, when a party of residents in Shanghai formed themselves into a small private company, under the title of the Woosung Road Company. This company bought a strip of land about 15 yards' wide reaching from Shanghai to Woosung, a distance of $9\frac{1}{4}$ miles. At their instance, the district magistrate, under the direction of the Taotai, issued a proclamation, bearing date the 26th March, 1873, giving notice that they had acquired possession of the land, and that they had a right to build bridges, cut ditches, erect fences, and construct a road suitable for the running of cars.

The scheme having assumed a practical shape, a company was formed under the title of the Woosung Road Company, Limited, and registered 28th July, 1874, under the Limited Liability Act, as a company having its head office in London, with a capital of £100,000. This new company took over the lands and the rights of the old company, bought a considerable amount of extra land, and formed an embankment along the entire length, the whole of the land being about the level of high-water springtides, and under the level of exceptionally high tides. The agents of the company in China are Messrs. Jardine, Matheson, and Co., with whom Mr. J. Dixon, of London, entered into a contract to construct a light railway on the embankment referred to, and work was commenced in January, 1876. Some difficulties hereupon ensued with the Chinese authorities, but on the company's making certain concessions as to the deviation of the line at some points, the work was allowed to proceed, and half the line, viz., that portion from Shanghai to Kangwan, was opened for public traffic, the inaugural trip being run on the 30th June, 1876.

Subsequently the Chinese authorities, who had been much displeased at the laying down of a railway without their previous permission, made an arrangement with her Majesty's Minister, through the medium of his Chinese secretary, Mr. Mayers, to the effect that they should buy the railway, and certain articles of agreement for carrying out this arrangement were drawn up at Nanking. These articles were afterwards agreed to by the company, subject to certain conditions; and having presented a statement of the cost of the line, the price of 285,000 Shanghai taels was agreed to by both parties, the company agreeing to produce their accounts to auditors appointed by the Chinese, one of whom should be a foreign bank manager resident at Shanghai. It was further settled that the price of the railway should be paid in instalments extending over one year, during which time the company were to retain possession of the line, and work it to their own profit. The auditors having expressed themselves satisfied with the accounts, the first instalment was paid on the 30th December. The running of the trains, which had been stopped for a time, recommenced on the 1st of December, 1876. During July and August the traffic amounted to a total of 16,894 passengers. During December the number of passengers was 17,527, of which latter number 15,873 were third class. Of this last class 7,946 took single tickets, and may, therefore, be assumed to be travelling on business; and a large number of those who took return tickets must have been *bonâ-fide* travellers; indeed, the company estimates that less than 3,000 third class passengers travelled merely to see the line, and there would, therefore, seem to be no fear that this part of the passenger traffic would fall off. The line has been constructed on a gauge of 2 ft. 6 in., with rails weighing 26 lbs. per yard, and is, therefore, merely an experimental line to test the feelings of the Chinese on the subject. Although light, it has been well constructed, and the general equipment of the line is tolerably complete. The company have already in China two passenger engines, one small engine, ten passenger carriages, and twelve waggons, while a further supply of rolling stock is ordered.

That the only remedy for lack of trade and poverty, the one means of developing the resources of a backward country, the sole specific for bringing rude nations into the van of civilisation, is the introduction of railways and telegraphs, has long been the dominant idea amongst the British residents in China, and is largely shared by what are called the "advanced thinkers" amongst the Chinese. Although looked upon with sullen, stolid disfavour by the agricultural population and the literary classes generally, yet the traders in the large inland tea and silk marts, such as Kangchow, Hoochow, and Soochow, are said to be very anxious to obtain these facilities, while the greater part of the Consular districts of Shanghai being a level alluvial plain, there are no engineering or other difficulties to cope with, beyond the promiscuous sprinkling over the face of the country of private graveyards, tombs, and the like, so that the price of land being low, the laying down of railways would probably prove to be comparatively inexpensive.

The Chinese, left to themselves, Consul Davenport says, are not in a position either to introduce a new

railway, or even to take charge of the one already existing. At a great loss, they have been able to run a fleet of steamers on the coast and the River Yangtze, but this is only accomplished by the liberal employment of foreigners on board of them to discharge every office of responsibility. If railways are to be introduced here, the capital must be provided by foreigners, and be supplemented with foreign engineers, station-masters, guards, engine-drivers, and also foreign material, such as rails, locomotives, carriages, and the like. In case the line were taken charge of by the present China merchants, or other semi-official company, their extravagance, inattention to details, and want of care generally, would raise the working expenses to such a height as would speedily absorb all the available receipts. Moreover, seeing that the creeks and canals in the province are gradually being filled up by the deposits brought down by the Yangtze, without any systematic efforts being made by the authorities to clean out and deepen them; that bridges are left unrepaired, and that as a general rule all public property is sadly neglected, it is in the last degree improbable that Chinese officials should, in the absence of a formidable experience, comprehend the necessity for minute care in the conservation of a railway line, rolling stock, &c. In the present condition of affairs the Chinese administration would not think of allowing a railway line to pass into the hands of unofficial natives, while, as a matter of course, the handing over the direction of a line to foreigners could only be brought about, if at all, by very skilful negociation. In short, it is not thought probable that railways will be established in China for many years to come.

GENERAL NOTES.

Hydrogeological Survey.—Under this title a series of maps is now being prepared by Mr. J. Lucas, and published by Messrs. Stanford. Their object is "to show at a glance the presence or absence of water in the rocks which outcrop at the surface of the earth." This is done by a conventional arrangement of colours. Surface contours and "artesian contours" are also given. The first sheet has been presented to the Society by Mr. Lucas, and can be seen in the Library. It contains an area of 216 square miles in the counties of Middlesex, Surrey, and Kent. It comprises parts of the basins of the Crane, Brent, and Mole, the whole of the basins of the Hog's Mill River, the Beverley and the Wandle, and the greater part of that of the Ravensbourne.

A New Use for the Cocoa-nut.—A new application of the kernel of the cocoa-nut has recently been made public. It seems that at Auckland, in New Zealand, a large factory has been erected for the conversion of cocoa-nut kernel into cattle food, the article taking the form of oil-cake, similar to that from linseed, sesamum, ground-nut, &c. The oil, which in itself is a valuable product, is first expressed from the nuts, which are imported from the South Sea Islands. It is suggested that this industry might be advantageously established in Fiji and on the Gold Coast, as well as in other countries where the cocoa-nut is indigenous, and where, consequently, the cost of freight of the raw material would be saved. As a cattle food cocoa-nut cake is highly recommended because of its sweet flavour, which it is said to impart to meat fed upon it.—*Gardeners' Chronicle.*

English Fruits in Australia.—Fruit crops of every kind in Australia have suffered in consequence of the long drought which has prevailed till within the last month or six weeks in all parts of Australia; but, except under circumstances like these, over which the agriculturist has no control, fruit culture is extending rapidly in most of the Australian colonies, and English fruits are among those most highly esteemed. Tasmania has hitherto been the principal producer of gooseberries, raspberries, strawberries, currants, and other wall fruits, for the production of which the climate of that colony is well adapted. In Victoria, which is not so well suited for the growth of these fruits, pears and apples are principally grown. It is a remarkable fact, however, that the imports of all kinds of fruit into this colony are largely increasing. Pine-apples, however, and oranges are imported from the more tropical parts of the country, and the natives of temperate climes from Tasmania. This fact is not wholly explained by the circumstance that the soil and climate of Victoria are not suited for the cultivation of fruits, but horticulturists find they cannot reckon on a regularly good crop, and that it pays better to import from adjoining colonies than to go to the expense of counteracting climatic disadvantages by artificial means. Strawberries are the exception to this rule, and this fruit is easily grown in most parts of Australia. In New South Wales the growth of English fruits is much more largely practised.—*The Colonies.*

Weekly Statistics of the Weather.—The Meteorological-office has begun to issue weekly statistics of the weather of the British Islands for agricultural and sanitary purposes. For this object the country is divided into two divisions, the one being suited for the production of wheat, and the other for the rearing of stock. For each of the ten regions into which these two divisions are sub-divided there are published the highest, the lowest, and the mean temperature of the week, and the degree to which the last is above or below the average of the week, together with the number of days of rainfall, its amount, and the difference between the latter and the average rainfall of the week. To these follow general remarks on the weather as regards frost, winds, storms, and any irregularity that may have occurred in the rainfall at the selected stations. This step is in the right direction, and the scheme will no doubt soon receive greater extension and further development in order that it may the fuller meet the requirements of the classes for which it is intended. It is desirable, for instance, if not indeed essential, that the mean temperature be given to tenths of a degree, and not merely to whole degrees, particularly when it is kept in view that no inconsiderable portion of Great Britain is but little removed from the limits of the successful cultivation of the wheat, and the rainfall to hundredths of an inch, so as to mark off clearly the practically rainless districts during each week. The number of stations situated on the coast preponderates too largely. Additional stations from several of the great agricultural centres are needed, and a partition of the country into more districts than ten, it being evident that a division of Scotland merely into east and west, and of Ireland into north and south, is inadequate. Scotland, for instance, should be divided at least into north-east, north-west, south-east, and south-west divisions, these differing essentially from each other in their climatic and agricultural peculiarities.—*Nature.*

NOTICES.

THE LIBRARY.

The following works have been presented to the Library:—

The Indian Meteorologists' Vade-Mecum. By H. F. Blandford. Parts 1 and 2. (Calcutta: 1876.)

Tables for the Reduction of Meteorological Observations in India. By H. F. Blandford. (Calcutta: 1876.)

Paris Universal Exhibition of 1878. Catalogue of the British Section. Parts 1 and 2. (Offices of the Royal Commission.) Presented by the Royal Commission.

Reports from the Select Committee on Colonisation and Settlement (India). April and August, 1859. Presented by Col. Hardy.

A Catalogue of the Antiquities and Works of Art Exhibited at Ironmongers'-hall, London, May, 1861

(London: 1863.) Presented by the Worshipful Company of Ironmongers.

The following works have been purchased for the Library:—

A Manual of Practical Hygiène. By Edmund A. Parkes, M.D., F.R.S. Edited by F. S. B. François de Chaumont, M.D. (London: J. and A. Churchill, 1878.)

Plain Needlework, arranged in Six Standards, as now required by the New Educational Code of 1877. By the Examiner of Needlework to the School Board of London. (London: Griffith and Farran.) (A pamphlet.)

Household Education. By Harriet Martineau. (London: Smith, Elder, and Co., 1876.)

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at eight o'clock.

May 15.—"Dietaries, in their Physiological, Practical, and Economic Aspects." By R. M. Gover, Esq., M.R.C.P., Lond.

May 22.—"Controlling and Correcting Clocks by Electricity." By Frederick J. Ritchie, Esq.

May 29.—"The Late Explorations in Mycenæ, Troy and Ephesus. By William Simpson, Esq., F.R.G.S. Illustrated by water-colour drawings, taken on the spot

African Section.

Tuesday evenings, at Eight o'clock.

May 14.—"The Niger: Past, Present, and Future." By E. Hutchinson, Esq., Lay Secretary to the Church Missionary Society.

May 28.—"A Year on the Nyassa, with Notes on the Slave Trade, and on the Prospects and Means of Opening up the Surrounding Country." By H. B. Cotterill, Esq.

Chemical Section.

Thursday evenings at eight o'clock.

May 23.—"The Position of Chemistry in a System of Technical Education, as illustrated by some of its applications." By J. M. Thomson, Esq., F.C.S., of King's College, London.

Indian Section.

Friday evenings at eight o'clock.

May 17.—"Agriculture in India." By F. C. Danvers, Esq.

Cantor Lectures.

Monday Evenings, at Eight o'clock. The Third Course, for the present Session, on "Some Researches on Putrefactive Changes, and their Results in relation to the Preservation of Animal Substances." By B. W. Richardson, Esq., M.D., F.R.S. The Fourth Lecture will be delivered on Monday, May 13; the dates for the remaining Lectures will be as follows:—May 20, 27.

Members can admit one friend to each lecture. Books of Tickets for the purpose were supplied to all the Members at the commencement of the Session.

MEETINGS FOR THE ENSUING WEEK.

Mon.....SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Dr. Benjamin W. Richardson, "Some Researches on Putrefactive Changes, and their Results in Relation to the Preservation of Animal Substances." (Lecture IV.)
Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. 1. Capt. H. Trotter, "Geographical Results of Sir T. D. Forsyth's Expedition to Kashgar in 1873-4."

Tues....SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (African Section.) Mr. E. H. Hutchinson, "The Niger: Past, Present, and Future."
Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. T. Thistleton Dyer, "Some Points in Vegetable Morphology." (Lecture III.)
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Discussion on "Steam Boilers for very High Pressures;" and, time permitting, Mr. T. C. Clarke, "The Designs generally of Iron Bridges of very large span for Railway Traffic."
Photographic, 5a, Pall-mall East, S.W., 8 p.m.
Anthropological Institute, 4, St. Martin's-place, W.C., 8 p.m. 1. Prof. George Rolleston, "Description of a Male Skeleton found at Cissbury." 2. "Excavations at Ligwell, in Cadbury, by the Committee of the British Association."
Royal Colonial, Pall-mall Restaurant. 14, Regent-street, W., 8 p.m. Mr. J. Robinson, "Glimpses of Natal."

Wed....SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. R. M. Gover, "Dietaries, in their Physiological, Practical, and Economic Aspects."
Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. W. W. Rundell, "The Daily Inequality of the Barometer." 2. Mr. C. N. Pearson, "Meteorology of Mozufferpore, Tirhoot, for the year 1877." 3. Mr. William Ellis, "Note on the great Rainfall of April 10th-11th, as recorded at the Royal Observatory, Greenwich." 4. Capt. W. F. Caborne, "Observations of Sea Temperature at slight depths."
Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m. Annual Meeting.
Archæological Association, 32, Sackville-street, W., Rev. R. E. Hooppell, "Exploration of the recently Discovered Roman Station at South Shields."
Society for the Development of the Science of Education, United Westminster (Endowed) Schools, Alexandra-street, Victoria-street, S.W., 7.30 p.m. Mr. C. H. W. Biggs, "Practical Lessons on Monoxide and Dioxide of Carbon."

Thurs...Royal, Burlington House, W., 8½ p.m.
Antiquaries, Burlington House, W., 8½ p.m.
Chemical Society, Burlington-house, W., 8 p.m. 1. Mr. H. J. H. Fenton, "The Action of Hypochlorites on Urea." 2. Mr. Thomas Bayley, "The Behaviour of Metallic Solutions with Filter Papers, and the Detection of Cadmium." 3. Mr. T. B. Hanway, "The Action of Bromine on Sulphur." 4. Dr. T. Carnelly and Mr. W. C. Williams, "The Determination of High Boiling Points." 5. Messrs. P. Muir and S. Suguira, "Essential Oil of Sage." 6. Dr. T. Carnelly, "High Melting Points."
Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Dr. John S. Phené, "Pen and Pencil Sketches in Brittany."
Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Colour." (Lecture III.)
Numismatic, 4, St. Martin's-place, W.C., 7 p.m.
Royal Society Club, Willis's Rooms, St. James's, S.W., 6 p.m.

Fri.......SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Indian Section.) Mr. F. C. Danvers, "Agriculture in India."
Royal United Service Institution, Whitehall-yard, S.W., 3 p.m. Mr. Thos. Brassey, "A Colonial Naval Volunteer Force."
Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Mr. A. Graham Bell, "Speech."
Philological, University College, W.C., 8 p.m. Annual Meeting. President's Address.
Royal Botanic, Inner Circle, Regent's-park, N.W., 4 p.m. Professor Bentley, "Classification, Properties, and Uses of Plants." Artificial System of Linnæus—General Sketch of its Classes and Orders. Of the Natural System now Generally in Use.—Its Sub-Kingdoms and their Characters:—1. Phanerogamia, Cotyledones, or Flowering. 2. Cryptogamia, Acotyledones, or Flowerless. (Lecture II.)

Sat.......Royal Institution, Albemarle-street, W., 3 p.m. Prof. Henry Morley, "Richard Steele." (Lecture III.)

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,330. VOL. XXVI.

FRIDAY, MAY 17, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

NATIONAL WATER SUPPLY.

The Congress on this subject will be held on Tuesday and Wednesday, 21st and 22nd May, 1878, at 11 o'clock. Sir UGHTRED KAY SHUTTLEWORTH, Bart., M.P., in the chair.

HEALTH AND SEWAGE OF TOWNS.

The Conference on this subject will be held on Thursday and Friday, 23rd and 24th May, 1878, the Right Hon. JAMES STANSFELD, M.P., late President of the Local Government Board, in the chair.

SANITARY EXHIBITION.

An Exhibition of Appliances connected with Sanitation and Water Supply will be held during the ensuing week. Members of the Society and visitors to the Congresses will be admitted free.

CHEMICAL SECTION.

Thursday, May 9, 1878; J. C. STEVENSON, M.P., in the chair.

The Chairman, in introducing Mr. Mactear, said that the subject about to be considered was one of great importance, and that Mr. Mactear's name was well-known in connection with it. Mr. Mactear's large experience in alkali works rendered him especially qualified to deal with the matter.

The Paper read was—

SOME RECENT IMPROVEMENTS IN THE PROCESSES CONNECTED WITH ALKALI MANUFACTURE.

By James Mactear, F.C.S., F.I.C.

When I think of the men who have spoken from this platform, and the brilliant discoveries and inventions with which you have been familiarised by their eloquent addresses, it is with the greatest diffidence, albeit at the special request of your Council, that I appear before you this evening, to give you an outline of some recent improvements which I have introduced into the various processes which constitute the alkali manufacture. The magnitude of this, the greatest by far of the chemical industries of the age, will be seen from the statistics in the following table:—

TABLE I.

Alkali Manufacture of the United Kingdom.

Raw Materials used.	1852.	1862.	1876.
Pyrites, and sulphur pyrites	124,262	264,000	376,000
Nitrate of soda........	4,800	8,300	12,200
Salt	137,547	254,600	538,600
Coals.................	519,420	961,000	1,890,000
Limestone and chalk ..	151,540	280,500	866,000
Manganese	12,000	33,000	18,200
Total raw material....	949,569	1,801,400	3,701,000
Number of hands employed in works ..	6,326	10,600	22,000
Wages paid them annually	£329,000	£549,500	£1,405,000
Capital employed in the manufacture estimated at......		£2,000,000	£7,000,000
Alkali at 48 per cent. (= salt, estimated)	Tons. 110,000	Tons. 203,600	Tons. 430,800
Alkali exported (all strengths)		104,762	270,856
Estimated value		£885,245	£2,209,284

The general term "alkali manufacture" includes an extensive series of chemical processes which may be divided into groups, thus:—

1st *Group.—Production of Sulphuric Acid.*

a. Combustion of the sulphur, and production of sulphurous acid.

b. Conversion in the leaden chamber by means of nitric acid, air, and steam, of the sulphurous acid into sulphuric acid.

c. Recovery of the nitrous compounds escaping from the leaden chamber.

2nd Group.—Decomposition of Common Salt by the Sulphuric Acid, with the production of Sulphate of Soda and Hydrochloric Acid.

a. Decomposition of the salt, and calcination of the sulphate of soda.

b. Condensation of the hydrochloric acid in water.

3rd Group.—Conversion of the Sulphate of Soda, by its Decomposition with Carbonaceous matter and Carbonate of Lime, into Carbonate of Soda and Sulphide of Calcium.

a. Decomposition of the mixture in the furnace, with production of "black ash" or crude soda.

b. Lixiviation of the crude soda with water, and separation of the carbonate of soda and sulphide of calcium.

c. Evaporation of the lixivium, and production of "soda salts," which in draining yield a quantity of "red liquor."

d. Calcination of the "soda salts," and production of soda ash or "alkali."

e. Solution of the soda ash in water, and production of soda crystals or refined alkali.

f. Production of caustic soda, either from the lixivium in *b*, or from the "red liquor" draining from salts in *c*.

4th Group.—The Utilisation of the Hydrochloric Acid produced in 2nd Group of Processes.

a. In the production of bleaching powder.

b. In the production of chlorate of potash.

c. In the production of bicarbonate of soda.

d. In the production of sulphur from the sulphide of calcium, or alkali waste produced in 3rd group of processes.

5th Group.—The Utilisation of the so-called Waste Residual Products.

a. Regeneration of the manganese employed in the production of chlorine for bleaching-powder and chlorate of potash manufacture.

b. Regeneration of sulphur from the alkali waste or sulphide of calcium.

It can be seen at a glance that the field for research and invention is a wide one, and its cultivation has not been neglected. Although much still remains to be done, in nearly all of the processes improvements, more or less revolutionary in their nature, have been introduced. Witness the regeneration of the manganese compounds in the bleaching powder manufacture by the Weldon process, which, by its own inherent merit, has overcome all opposition, and stands unrivalled in its success compared with any other process introduced within this century. The boon conferred on the consumer by a much cheapened cost of bleaching powder is one which must amount to many thousands of pounds annually; and the great merit and value of the invention has deservedly been rewarded by that rare and coveted distinction the award of the Lavoisier Medal by the Société d'Encouragement pour l'Industrie Nationale de France.

I cannot pretend to put before you anything of so grand a character, but, like the mouse in the fable of the lion caught in the net, must be content to nibble at the cords which still hamper and confine, with the hope of having snapped one or two at least, and thus leaving the task an easier one for others to complete.

The direction in which improvements are naturally to be expected may be stated under three heads:—

(*a*) The detection and prevention of loss in the various operations.

(*b*) Modification of existing processes.

(*c*) Introduction of processes entirely new.

GROUP I.—SULPHURIC ACID.

(*a*) *Detection and prevention of loss.*—The importance of a good method of estimating the loss which takes place in the manufacture of sulphuric acid, both as regards the interest of the manufacturer and the public, can scarcely be overstated. An examination of the figures given in the Eighth Annual Report of the Inspector of Alkali Works will suffice to show the large amount of sulphur acids allowed to escape into the air, through either carelessness or ignorance on the part of the persons in charge.

The average in grains per cube foot, calculated from the examination of 56 cases, is given as follows:—

TABLE II.

	Grains per cube foot.
Hydrochloric acid	0·0525
Sulphuric anhydride	2·2609
Sulphurous acid	5·5464
Total acids as sulphuric anhydride	8·3484
Equal to strong sulphuric acid or vitriol	10·2268

This, when calculated out as loss per cent. of H_2SO_4 on "sulphur bought," would show a loss of about 22 per cent., and within the past month a case has been brought to my knowledge of an escape of over 25 per cent., where the manager "was certain he was doing the best that could be done."

As a measure of the efficiency of their management, sulphuric acid makers place great reliance on their yields of oil of vitriol (or of sulphate of soda), and this would, no doubt, be guide enough were it not for the difficulty of obtaining reliable figures. The calculation of these yields is so involved in doubt as to the correctness of weights, measures, consumption of raw materials and stocks, as well as temperature and specific gravity of the acid produced, that the ultimate result is, at least, of very doubtful accuracy.

The method which I have introduced for checking the results in the vitriol manufacture, and which is now very widely adopted by my manufacturing friends, proceeds on the principle that it is much more satisfactory to know what is lost rather than a mere approximation of what is obtained.

The apparatus employed is very simple, and was first designed and applied by me in the testings of the escapes of "noxious vapours," generally in the year 1873. It consists of a Bunsen water pump for aspirating the gases to be examined, an absorbing apparatus filled with liquids suited to the occasion, a separating vessel (where the washed gases and water are separated), and a meter to measure the residual gases.

This apparatus attached to the outlet flues of the leaden chamber—or rather to those of the Gay Lussac (or absorbing) towers, as these should form a part of all well-arranged sulphuric acid plant—gives a simple means of obtaining the total sulphur acids escaping per cubic foot. It remains to know the relation this bears to the actual loss of sulphur.

The method of stating the results which I have adopted and which I recommend, is that of representing the escapes as per-centage loss of oil of vitriol (H_2SO_4) on 100 sulphur, bought or burned as may be preferred, and the calculation proceeds on the following principle.

Let us take as a basis in the first instance one ton of pure FeS_2, and assume that perfect combustion takes place, we have then the decomposition—

$$2\,FeS_2 + 15O = Fe_2O_3 + 4\,SO_3$$

20 cwt. of pyrites (pure) requiring, therefore, 20 cwt. oxygen. As 20 cwt. of oxygen is contained in 87 cwt. of air, there would therefore pass away as residual gas, nitrogen equal to 67 cwt., which is equal to a bulk of 101,158·4 cube feet, at standard temperature and pressure.

Assuming for the moment that air contains 20 per cent. by volume of oxygen, and that in the

residual escaping gases, after complete decomposition and condensation, there is found 10 per cent. by volume of oxygen, it is evident at once that one-half of the bulk of the escaping gases must be air, and that, therefore, the escaping gases must be equal to the nitrogen volume $\times$ 2 for pure pyrites, as above, for 20 cwts.:—

	Cube feet.
Nitrogen	101,158·4
Air (at 20 per cent. O)	101,158·4
	202,316·8

As, actually, the correct per-centage of oxygen in the air is 20·8 per cent., the corrections will be $X = V \times {\cdot}926$, when X equals volume of air of 20·8 per cent. and V the volume of nitrogen in cubic feet, giving—

Nitrogen	101,158·4
Air (at 20·8 per cent. O)	93,672·6
	194,831·0

as the residual volume of escaping gases from 20 cwts. of pure $Fe\,S_2$, assuming them to contain 10 per cent. of oxygen by volume.*

Under manufacturing conditions, of course, we have to deal with a different state of matters. Using, in the first place, an impure pyrites, which will contain, as a rule, about 47·5 per cent. of sulphur together with small quantities of lead, zinc, arsenic, &c., it will not affect our results appreciably if we neglect the effect of these as well as that of the nitrate of soda employed.

In practice it is always found that a considerable amount of the sulphur remains unburnt in the residue, or "burnt ore," depending chiefly on the more or less skilful management of the kilns, and the amount burnt off, or "available sulphur," may be calculated by the formula—

$$\frac{A - (B \times W)}{100}$$

where A = per cent. of sulphur in pyrites.
B = " " residue.
W = " residue from pyrites.

In the case of pyrites of 47·5 per cent. of sulphur, yielding say 70 per cent. of residue, containing say 3·57 per cent. of unconsumed sulphur, we have—

$$47{\cdot}5 - \frac{(3{\cdot}57 \times 70)}{100} = 45 \text{ per cent. available.}$$

This $+$ 1897·9 (a constant for air of 20·8 per cent. oxygen) gives the volume of nitrogen due to the combustion of 20 cwts. of such pyrites as we are considering, when burnt under such conditions. This nitrogen volume multiplied by the factor C', corresponding to the amount of oxygen in the escaping gases, gives the air associated with the nitrogen.

With an amount of oxygen in the residual gases equal, after complete condensation and absorption, to 10 per cent. by volume, we would therefore have, for the case we are considering—

Nitrogen	85,405·8	cubic feet.
Air	79,085·8	" "
	164,491·6	" "

as the volume of escaping residual gases from one ton of such pyrites, burned under the conditions stated. The available sulphur divided by the residual gases gives an amount of 42·9 grains sulphur per cube foot, so that, were all the sulphur to escape, as 100 sulphur = 306·25 $H_2\,SO_4$, 42·9 grains per cubic foot of escaping gases would be found and show the escape to be 306·25 per cent. $H_2\,SO_4$ on 100 available sulphur, therefore one grain of sulphur found in each cubic foot of escaping gases would equal a loss of 7·139 per cent. $H_2\,SO_4$ on the "available sulphur."

The "available sulphur" being, in the case we are assuming, 94·737 per cent. of the "sulphur bought," one grain of sulphur per cube foot equals

* Once the principle of this calculation is grasped it can be much simplified, but I have thought it best to explain it somewhat fully for the sake of clearness.

TABLE III.—*Giving Value of C' for various per-centages of Oxygen in Residual Gases.*

Nitrogen Volume $\times$ C' = Air Volume; Oxygen in Air, 20·80 per cent.

Per cent. O found.	Factor.	Per cent. O found.	Factor.
12·0	1·363636	6·9	·496403
11·9	1·337079	6·8	·485714
11·8	1·311111	6·7	·475177
11·7	1·285714	6·6	·464789
11·6	1·260869	6·5	·454545
11·5	1·236559	6·4	·444444
11·4	1·212766	6·3	·434483
11·3	1·189474	6·2	·424658
11·2	1·166666	6·1	·414966
11·1	1·144330	6·0	·405405
11·0	1·122449	5·9	·395973
10·9	1·101010	5·8	·386667
10·8	1·080000	5·7	·377483
10·7	1·059406	5·6	·368421
10·6	1·039216	5·5	·359477
10·4	1·000000	5·4	·350649
10·3	·980952	5·3	·341935
10·2	·962264	5·2	·333333
10·1	·943925	5·1	·324841
10·0	·925926	5·0	·316456
9·9	·908257	4·9	·308716
9·8	·890909	4·8	·300000
9·7	·873874	4·7	·291925
9·6	·857143	4·6	·283951
9·5	·840708	4·5	·276074
9·4	·824561	4·4	·268293
9·3	·808696	4·3	·260606
9·2	·793103	4·2	·253012
9·1	·777778	4·1	·245509
9·0	·762712	4·0	·238095
8·9	·747899	3·9	·230769
8·8	·733333	3·8	·223529
8·7	·719008	3·7	·216374
8·6	·704918	3·6	·209302
8·5	·691057	3·5	·202312
8·4	·677419	3·4	·195402
8·3	·664000	3·3	·188571
8·2	·650794	3·2	·181818
8·1	·737795	3·1	·175141
8·0	·625000	3·0	·168539
7·9	·612403	2·9	·162011
7·8	·600000	2·8	·155555
7·7	·587784	2·7	·149171
7·6	·575578	2·6	·142857
7·5	·563910	2·5	·136612
7·4	·552239	2·4	·130435
7·3	·540741	2·3	·124324
7·2	·529412	2·2	·118280
7·1	·518248	2·1	·112299
7·0	·507246	2·0	·106383

$$\frac{94{\cdot}737 + 7{\cdot}139}{100} = 7{\cdot}76$$

as the loss of $H_2\ SO_4$ on 100 "sulphur bought."

The whole of the testing apparatus is fitted up in locked cupboards, to prevent its being tampered with, and the meter is fitted with an index so arranged that, by observing the reading for one minute, the rate of passage per hour is given by direct indication, so that the rate of aspiration is easily regulated.

The result may be very usefully stated thus, whenever stocks can be correctly checked—

	Tons.
Pyrites used—	
= sulphur..........................	
O. V. made by measure	
Production of O. V. on sulphur bought ..	284·58
Loss as unburnt sulphur in residue	18·54
„ in escaping gases	2·37
„ unaccounted for	·76
	306·25

For my own part, I prefer the form of a diagram, such as I have here, on which each day the loss is laid down in lines to a scale, and which, at a glance, shows whether the results are good or bad. Each diagram represents the work of one month. I have found the representing of the loss in inches in this way brings home the facts to an ordinary workman or foreman in a way that no mere figures ever will do, and I now look on these diagrams as a very valuable aid to the working of my vitriol chambers.

It has been abundantly proved by experience that under the usual "rule of thumb" system of working chambers, there often takes place a considerable loss of sulphur gases, even when the nitrous compounds are in large excess, and that, by inspection alone of the appearance of the leaden chambers, it is practically impossible to obtain steady results, the testing of the escapes in such cases showing the most irregular variations. On the other hand, the application of such a system of testing as that which I have introduced indicates at once if matters have been out of order, and in every case where it has been applied, there has resulted a large reduction in the amount of the sulphur gases escaping. The following cases show how very satisfactory indeed have been the results :—

A.—A large works having a number of series of sulphuric acid chambers.

Month.	Average.	Maximum.	Minimum.
1st.	7·00	26·96	1·00
2nd.	2·96	10·60	·80
3rd.	4·21	29·75	·80
4th.	2·37	8·30	·40
5th.	1·68	2·60	·50

The monthly average, with the maximum and minimum escape for the month, are given in terms of $H_2\ SO_4$ on 100 of sulphur burnt.

B.—A large manufactory with chambers of varying size and arrangement.

The escape in this case was calculated as pounds weight of $H_2\ SO_4$ escaping per hour. In the first month in which the system of testing was employed, the escape was as high as 133 pounds per hour, it was in a comparatively short time reduced to from 18 to 21 pounds per hour, a reduction in the amount escaping of about 80 per cent.

The nitrous compounds escaping are tested by the same apparatus, and the amounts are tabulated in the same diagramatic form, preferably in the form of grains of nitrate of soda per cubic foot, so as to have the apparent loss as high as possible to strike the eye distinctly.

The long series of daily testings which I have had carried out show the curious fact that the loss of nitrous compounds takes place to a much greater extent when the SO_2 escape is also large; in fact, an increase in the escape of SO_2 seems invariably to be accompanied by an increase in that of the nitrous compounds. I have been investigating this subject for many months, but, as can be imagined, it requires a long and careful series of daily observations to enable one to offer a definite opinion on such a subject.

It seems as if the SO_2, passing through the Gay Lussac tower, reduced a portion of the $N_2\ O_3$ to $N_2\ O_2$, which passes off to the chimney, no doubt quickly oxidised by the excess of air always present in the escaping gases.

There is no insuperable difficulty in keeping down the escape of the sulphur acids to 2·5 per cent. $H_2\ SO_4$ on the sulphur bought; indeed, were it not for the occasionally higher escapes when starting to work a series of chambers after a stoppage, or occasions of a similar nature, the escapes need never be over this figure, which should almost remove these escapes from the category of noxious vapours when compared with the amount of sulphur acids evolved from coal. I have found the sulphur gases in a kitchen chimney to amount to—

·32 grains SO_2 per cubic foot.

The following figures give some idea of the enormous amount of sulphur acid gases evolved by the combustion of coal in the United Kingdom. The data have been obtained from the Government returns for 1875 :—

	Tons.
Total coal raised in the United Kingdom	131,867,105
Shipped to foreign countries	14,544,916
Leaving............................	117,322,189
Shipped for use of steamers engaged in foreign trade......................	3,278,249
Leaving as consumed in the United Kingdom	114,043,940
Which, at 1 per cent., will give as sulphur	1,140,439
Or, in round numbers, as oil of vitriol....	3,500,000

It is instructive to compare this with the amount given off in the manufacture of sulphuric acid.

For the same year, 1875, we have :—

	Tons.		Tons.
Brimstone imported	55,877	....	....
If all used for vitriol making and 98 per cent. burnt off	....	....	54,759
Pyrites imported..........	539,256	....	....
Sulphur contents at 47·5 per cent.	256,146	....	....
Burnt off (residues averaging 5 per cent...........	....	....	237,272
Total sulphur burnt ..	....	....	292,031

Escaping into atmosphere at 5 per cent. lost..........	14,601
Equal to oil of vitriol	44,716

being only about $\frac{1}{78}$ of the amount given off from the combustion of the coal, or, say, 1·28 per cent.

	Tons.
The coal consumed in London alone is estimated at over	8,000,000
Equal at 1 per cent. sulphur	80,000
Or, as oil of vitriol........................	245,000

equal to more than five times the amount evolved from all the sulphuric acid works of the United Kingdom.

These figures are so striking in themselves as to require no comment.

b.—Modification of existing Processes.—Before describing an improvement in the method of working the leaden chambers which I have introduced, I must ask you to bear with me while I describe shortly the conditions which obtain in the usual system of manufacture.

A series of leaden chambers, six in number, all of equal size, and worked in "single file," at the rate of about 50 pounds sulphur per 24 hours for each 1,000 cubic feet of total space, were found to give the following results:—

TABLE IV.

Week ending 29th March, 1877.

No. of Chamber.	Acid made.	H_2SO_4 in Acid made.	Excess Water.	Per cent. of H_2SO_4 made in the various chambers.
1	23·52	19·89	3·63	32·20
2	22·59	18·68	3·91	30·26
3	20·35	14·89	5·46	24·11
4	10·23	4·35	5·88	7·04
5	5·84	3·09	2·75	5·00
6	2·19	·86	1·33	1·39
	84·72	61·76	22·96	100·00

Average loss 1·49 per cent. H_2SO_4 on sulphur burned.

I would direct specially your attention to the last column of figures in the table where the proportionate amount of H_2SO_4 produced by each chamber is shown, and where the striking fact is brought out clearly that 86·5 per cent. of the total production of acid takes place in the first three chambers, while in the last there is only about 1·5 per cent. or less than 1-20th of the work of the first chamber. Investigations of this nature carried out on series of vitriol chambers of very varied size and arrangement, give results of exactly similar character, and in the series of diagrams before you I have attempted to show the relative proportions of SO_2 and nitrous compounds calculated as N_2O_4 on the total bulk of the gases in the various chambers, &c., and I have further embodied the figures obtained, in the following series of tables, which are calculated out on a basis of 100 grammes of sulphur, obtained by the combustion of $Fe S_2$, nitrous compounds equal to 10 per cent, Na No_3 on the sulphur, calculated as N_2O_4, and the residual gases escaping with 10·4 per cent. of oxygen, ·33 grains (nitrous compounds) calulated as Na No_3 per cubic foot, and ·5 per cent. of the original sulphur escaping as SO_2.

TABLE V.—LITRES OF GASES.

	Total.	Centesimally.	Per 100 of SO_2.
Gases entering denitrating tower:—			
SO_2	69·754	6·325	100·000
O for conversion of SO_2 into SO_3..........	34·790	3·155	49·875
N equal to O fixed in Fe_2O_3 and SO_3 ..	499·109	45·260	715·527
O of air in excess	103·815	9·414	148·831
N of air in excess......	395·294	35·846	566·697
	1,102·762	100·000	1,480·930
Gases entering first chamber:—			
SO_2	69·754	6·318	100·000
O for conversion of SO_2 into SO_3..........	34·790	3·151	49·875
N equal to O fixed in Fe_2O_3 and SO_3 ..	499·109	45·206	715·527
O of air in excess	103·815	9·403	148·831
N of air in excess......	395·294	35·803	566·697
N_2O_4................	1·315	·119	1·885
	1,104·077	100·000	1,482·815
Gases entering second chamber:—			
SO_2	47·782	4·461	100·000
O for conversion of SO_2 into SO_3..........	23·776	2·220	49·759
N equal to O fixed in Fe_2O_3 and SO_3 ..	499·109	46·598	1,044·554
O of air in excess	103·815	9·693	217·268
N of air in excess......	395·294	36·905	827·287
N_2O_4................	1·315	·123	2·752
	1,071·091	100·000	2,141·620
Gases entering third chamber:—			
SO_2	27·365	2·630	100·000
O for conversion of SO_2 into SO_3..........	13·542	1·302	49·486
N equal to O fixed in Fe_2O_3 and SO_3 ..	499·109	47·971	1,823·896
O of air in excess	103·815	9·978	379·372
N of air in excess......	395·294	37·993	1,444·524
N_2O_4................	1·315	·126	4·805
	1,040·440	100·000	3,702·083
Gases entering fourth chamber:—			
SO_2	14·314	1·402	100·000
O for conversion of SO_2 into SO_3..........	7·000	·686	48·903
N equal to O fixed in Fe_2O_3 and SO_3 ..	499·109	48·892	3,486·859
O of air in excess	103·815	10·169	725·269
N of air in excess......	395·294	38·722	2,761·590
N_2O_4................	1·315	·129	9·187
	1,020·847	100·000	7,031·808

	Total.	Centesimally.	Per 100 of SO_2.
Gases entering fifth chamber :—			
SO_2	7·115	·704	100·000
O for conversion of SO_2 into SO_3	3·392	·336	47·674
N equal to O fixed in Fe_2O_3 and SO_3	499·109	49·415	7,014·884
O of air in excess	103·815	10·278	1,459·100
N of air in excess	395·294	39·137	5,555·7 4
N_2O_4	1·315	·130	1° 482
	1,010·040	100·000	14,095·924
Gases entering sixth chamber :—			
SO_2	2·616	·261	100·000
O for conversion of SO_2 into SO_3	1·136	·113	43·425
N equal to O fixed in Fe_2O_3 and SO_3	499·109	49·748	19,079·090
O of air in excess	103·815	10·347	3,968·463
N of air in excess	395·294	39·400	15,110·627
N_2O_4	1·315	·131	50·268
	1,003·285	100·000	38,251·873
Gases entering absorbing towers :—			
SO_2	·349	·035	100·000
O for conversion of SO_2 into SO_3	..	..	..
N equal to O fixed in Fe_2O_3 and SO_3	499·109	49·917	143,011·175
O of air in excess	103·815	10·382	29,746·418
N of air in excess	395·294	39·534	113,264·757
N_2O_4	1·315	·132	376·791
	999·882	100·000	286,399·141
Residual gases leaving absorbing towers :—			
SO_2	·349	·035	100·000
O for conversion of SO_2 into SO_3	..	..	..
N equal to O fixed in Fe_2O_3 and SO_3	499·109	49·978	143,011·175
O of air in excess	103·815	10·395	29,746·418
N of air in excess	395·294	39·582	113,264·757
N_2O_4	·099	·010	28·367
	998·666	100·000	286,050·717

The nitrous compounds have throughout been calculated for the sake of simplicity as N_2O_4 and no notice has been taken of the amount of nitrous compounds absorbed by the acid in the various chambers. This is, however, a considerable element when dealing with the loss of nitrous compounds, as the amount in the acid run from the chambers under the more usual conditions of working varies from about 15 per cent. to 30 per cent. of the nitrate of soda used, depending on the strength of the acid in the chambers, and the more or less rich character of the gases in nitrous compounds.

In the set of chambers such as we are now considering, worked under normal conditions with the last chamber containing acid of say 90° to 100° Twaddel, it will be found that a very large proportion of the nitrous compounds in the acid exist in a state of oxidation equal to N_2O_5. It is chiefly to this we owe the tear and wear of the last chamber, more especially when excess steam has been carelessly allowed to enter the chamber and dilute the acid, the lead in such cases being often cut round the surface line of the acid as with a knife.

It is after consideration of facts and figures such as these that I have introduced the following improved system of working the chambers, which, extremely simple as it is, has shown great promise of reduction in the tear and wear of the lead of the chambers, and has also resulted in a considerable saving in the amount of nitrate of soda required.

The improvement consists in causing the acid in the series of chambers to be kept in constant circulation towards the inlet of sulphurous acid gas. I prefer to attain this object by the use of a self-acting apparatus, which, designed many years ago by Mr. Blair, deserves to be more generally known. A very good description of the apparatus and its mode of operation can be seen in Richardson and Watts' "Chemical Technology," vol. I., part V., page 217. By means of this or other convenient apparatus, the acid of the first chamber which contains SO_2 is thrown into the the last chamber, and we have the N_2O_5 in the acid in it decomposed, and N_2O_4 thrown off; we are therefore able to reduce to an extremely small amount the nitrous compounds in the acid of this chamber, and not only so, but it is found that the quantity of nitrate of soda required to work a set of chambers upon this system is considerably less than under the usual method is required. Further, the acid may be safely kept at a considerably higher degree of concentration to the extent of 10° to even 15° Twaddel, and the danger of loss of nitrous compounds in the lower forms of oxidation produced by the action in the last chamber of aqueous vapour and dilute acid on the N_2O_4 and N_2O_5 is reduced very greatly.

Group II.—Decomposition of Common Salt.

In connection with this group of processes, I have no completed improvements to lay before you, unless it may be the application of the testing apparatus described under sulphuric acid for checking the escapes. By means of this apparatus, daily and weekly average tests are easily obtained, and have been found most useful and satisfactory.

Group III.—Decomposition of the Sulphate of Soda with Carbonaceous Matter and Carbonate of Lime into Carbonate of Soda and Sulphide of Calcium.

Notwithstanding the immense number of methods which from time time have been proposed for the production of alkali, the process invented and worked out by Leblanc and his associate Digh, still holds it own for the simplicity of its operations, and the low cost and abundance of its primary raw materials. That it has remained almost without alteration during over three quarters of a century, is due to a large extent to the elaboration of a theory of its decomposition by Dumas, which, based on the quantities of the various substances used in practical working, and founded on the idea of the incompatability of carbonate of soda and of sulphide of calcium in presence of water, unsupported by one reliable experiment, has acted as a bar in the way of

advancement in this direction. Dumas reduced the composition to a formula—

$$2\ Na_2\ SO_4 + 3\ Ca\ CO_3 + 12\ C.$$
$$2\ Na_2\ CO_3 + 3\ CaO,\ 2\ CaS + 10\ CO + 3\ C.$$

corresponding to a proportion in the mixture for decomposition of—

Sulphate of soda	100 parts.
Carbonate of lime	103 ,,
Carbon	50·8 ,,

This theory and decomposition formula have been discussed and disputed times without number, the insoluble calcium compounds having been variously described as—

$$3\ CaS,\ CaO.$$
$$2\ CaS,\ CaO.$$
$$CaS,\ CaO,\ HO.$$
$$CaS.$$

Messrs. Dubrunfaut, Gossage, and Scheurer Kestner, have all taken a prominent part in removing the curtain of ignorance from the decomposition, which they show to result in simple CaS; although they have clearly enough proved this, it has still always been looked upon as necessary to use a large excess of carbonate of lime in addition to that required as shown by the formula—

$$Na_2\ SO_4 + Ca,\ CO_3 + 4\ C.$$

and in practice, then, a mixture has been most commonly used approximating to—

Sulphate of soda	100 parts
Limestone	108 ,,
Coal	50 to 60 ,,

It is no doubt due to this fact of the employment of an excess quantity of limestone that the authors of most of our text-books on chemistry insist on giving us the old explanation of the formula of Dumas, with its formation of an oxysulphide; whilst some of the more recent among them have succeeded in still further complicating matters by formulating the decomposition as—

$$5\ Na_2\ SO_4 + 20\ C = 5\ Na_2\ S + 20\ CO$$
$$5\ Na_2\ S + 7\ Ca\ CO_3 = 5\ Na_2\ CO_3 + 5\ Ca\ S$$
$$2\ CaO + 2\ CO$$

a re-action which, however pleasing to the imagination, has certainly no foundation whatever in fact.

It is astonishing how much habit seems to obtain even in such things, and we find that the decomposition of sulphate of soda by carbon is accepted without difficulty as being most simple in its character,—

$$Na_2\ SO_4 + 2\ C = Na_2\ S + 2\ CO_2$$

when in reality it is a much more complicated re-action than that of the carbonate of lime with the sulphide of sodium.

I had long felt dissatisfied with the explanation of the necessity for the use of the excess of limestone usually employed; and having instituted a long series of experiments, which proved to me the soundness of the theory that only one equivalent of carbonate of lime was required for the decomposition of the sulphate of soda, I tried to apply the principle to practical working on the large scale. I was met at the outset by the difficulty of having insoluble black ash, but I satisfied myself that the decomposition of the sulphate of soda was quite perfect, and I thus had the problem narrowed to that of the separation of the carbonate of soda and sulphide of calcium by lixiviation.

It having been well established that there was a distinct connection between the solubility of the black ash and the amount of caustic soda found in the lixivium, and that this, again, depended upon the excess of limestone used, I came to the conclusion that, if caustic lime in pieces were distributed through the mass of black ash, its disruptive force in slaking would rend the balls in pieces and allow of their exhaustion in the vats. On applying this idea practically, I found it to succeed perfectly; and the improved process as now worked is based on this principle.

This process was not worked out without great labour and many experiments on the large scale. It had been the practice of most manufacturers to follow the method of working introduced by Messrs. Stevenson and Williamson, of Jarrow, as applied to revolving furnaces, of first heating the carbonate of lime with a portion of the coal so as to produce a certain quantity of caustic lime, and which, owing to the much lower heat of a revolving furnace when compared with a hand furnace, is apparently not formed in any quantity when this plan is not followed.

This was the point from which my investigations started, and having (no doubt like many others) the idea that it was absurd to use an expensive machine, like a revolving ball furnace, merely as a lime kiln, I went on with experiments amounting to several hundred, which, when carefully tabulated, showed that perfectly good black ash could be made without the so-called liming operation, but that the balls were apt to be very insoluble, that good results could be obtained by charging all the materials at once, and with only one equivalent of carbonate of lime, but again with insoluble balls and also great danger of over-fired black ash, while the best results by far were obtained by the method which I have introduced of using as nearly as possible one equivalent of carbonate of lime, and charging all at once. The furnace is made to revolve rather slowly at first, the usual melting and decomposition of the sulphate of soda takes place, and when all the sulphate has been decomposed, which is known by various strongly marked indications, the furnace is stopped, and a quantity of caustic lime in pieces is dropped in; the furnace is again started, and the lime mixed through the charge as rapidly as possible, and the whole withdrawn without loss of time. The addition of the lime at this stage chills the molten mass, and prevents the overheating of the black ash, thus obviating one great danger in decomposing the last trace of sulphate of soda.

It is sometimes advisable to add with the lime a small quantity of coal or even cinders, with the view of keeping the mass of black ash as porous as possible; this depends very much on the quality of the mixing coal, which ought to be of such a character as to leave a considerable amount of coke in the waste; this, in the ordinary system of working, usually amounts to about 10 per cent. on the waste, or about 20 per cent. of the original coal used.

By the use of cinders, which I strongly recommend, there is of course a gain in the saving of a proportionate amount of coal.

The advantages of this simply conducted process are very great:—

Firstly. By its use the output of the furnaces has been increased from 50 to 70 per cent.

Secondly. There is a very great economy in limestone and coal.

Thirdly There is a much reduced quantity of alkali waste.

Fourthly. There is a considerably increased yield of alkali from a given quantity of sulphate of soda.

(1.) As regards the increased output from a given furnace, this not only gives greater productive power to the plant, but results in a considerable saving in wages; the weight of total raw material per ton of sulphate of soda decomposed being reduced by some 20 per cent., it naturally follows that the weight of material handled being less, so also are the costs of labour in the moving of raw material, working the furnaces and vats, and dealing with the waste.

(2.) The limestone used in excess in the ordinary method of Leblanc naturally gives considerable infusibility to the mass, and thus necessitates a greater consumption of coal for its fusion, whereas by my improved system the quantity of limestone being kept as low as possible, and the fusibility of the mixture being thus much increased, there results a considerable saving in fuel.

(3.) The reduction in the amount of waste (about 30 per cent.) is of advantage in various ways:—

(*a*) The quantity of waste being reduced, and the per-centage amount of alkali left in it after lixiviation being no more but less, than on the old system, there is of course a gain in alkali which has been found to amount to about 2½ per cent.

(*b*.) The cost of removal of the waste and its deposit is the source of a very considerable expense to the manufacturer, and being, of course, exactly in proportion to the amount of waste produced, there is much less cost for this purpose on the new method than on the old.

(*c*.) As it is almost a certainty that the regeneration of the sulphur contained in the alkali waste will ere long form one of the regular processes of an alkali work, owing to the necessity of condensing and utilising all the muriatic acid for which there is at present, it may be said, an outlet only in the manufacture of bleaching powder, it is clearly of great advantage to have the waste in a form in which there is as little as possible of useless material, such as carbonate of lime, so that it may be dealt with the more easily in the way of oxidation, &c.

(4.) The reduced quantity of waste gives, as above, an increase in the yield of alkali, but, above and beyond this, is also the fact that better decomposition of the sulphate of soda is obtained, as might be expected, from the greater fusibility and, therefore, liquidity of the molten mass, which renders the agitation and mixture more complete.

This process has now been used in the works of my firm, Messrs. Charles Tennant and Co., for some years, and has also been adopted with marked benefit by various large manufacturers both in this country and in France.

The tear and wear of the furnace is considerably reduced, and the money saving in this country may be said to range between five and ten shillings per ton of soda ash, calculated as of 48 per cent. of alkali, varying, of course, in each district with the costs of raw material and labour. In the case of my own firm, the savings effected by the introduction of the "Mactear system" has resulted, in round numbers, to over £19,000 per annum.

One of the greatest improvements in the manufacture of alkali was the so-called revolving furnace invented by Elliot and Russel in 1853. It consisted of a cylinder of iron lined with brick, and made to revolve on bearing wheels, but owing to the small size and defective mechanical construction of these furnaces, at first the results were not so successful as were expected. From time to time, however, these furnaces have been improved and increased in size, and from the original furnaces of this description which worked some nine tons of sulphate of soda per day, we have now furnaces of a modified form, which I designed in 1873, which work 50 tons per day with ease.

I have here a drawing of the most recent furnace which I have designed and erected, which, when worked with limestone, has decomposed at the rate of over 330 tons of sulphate of soda per week of six days.

All the arrangements connected with this furnace have been most carefully thought out, they are deduced from my experience of the results of over twenty-five revolving furnaces, and have amply realised my expectations as to the practical results obtained.

d.—The Calcination of the "Soda Salts" and Production of Soda Ash or Alkali.

The calcination of the salts obtained by the evaporation of the lixivium from the black ash is in most cases performed in furnaces worked by hand, and it has been the aim of many inventors to design a mechanical furnace which might replace the laborious operation of "carbonating" by hand. The high wages and scarcity of labour of the class required during the last few years has stimulated invention in this direction, and at various times furnaces have been introduced by Messrs. W. W. Pattinson, J. M. Napier, Gibb and Gelstharp, Furlonge and Churchill, and others, with comparatively little success. The furnace which I have invented and introduced has been highly successful, and has been extensively adopted by the most important manufacturers, in the works of my own firm, and in those of the Newcastle Chemical Works Company (late C. Allhusen and Sons) it has quite superseded the old hand furnaces, while the Jarrow Chemical Company are now engaged in erecting their fourth furnace.

Essentially it consists of a revolving circular bed of, say, 21 feet in diameter, made of boiler plate, carried on cast-iron arms or girders radiating from a hollow central casting, the bed having also an opening in its centre corresponding to the hollow centre piece; these arms carry each a wheel bevelled on the tread, and these run on a rail or race, which has a bevelled face and a flange on the inner side, as a guide for the train of wheels; this race is carried on two massive foundation piers of brickwork, with a roadway between, through which run the waggons into which the finished alkali is to be discharged. On these brick piers are carried iron columns, which support an angular curb piece, which acts as support and binder for the arch of the furnace.

The keystone of the arch is a cast-iron ring corresponding to the hollow centre of the bed, but of slightly larger diameter, and through this opening in the arch, rises and falls as required a closing piece, clothed, so to speak, with brickwork, held in its position by a groove at the bottom, and a light iron hoop at the top. By the raising of this central plug, the opening in the bed is uncovered, and through it the roasted material is discharged.

The iron pan is lined out with brick, and round the outside is formed a lute into which a cast-iron flange (from the support of the arch) dips, and as the lute gets filled with the material under treatment in the furnace, it effectually prevents the access of cold air which would otherwise take place.

The stirring gear is placed in what may be called the shadow of the central plug, so as to be protected from the heat, and the products of combustion are carried off by two flues placed one on each side of the stirring gear.

In a furnace of the above size (21 feet diameter) we have finished at the rate of 150 tons soda ash weekly, the cost of labour being under one shilling per ton, or less than one-third the cost of finishing by hand, this being for very highly finished ash; when the salts are merely dried, of course the quantity is much greater and the cost less. Two furnaces are easily worked by three men, and there is a considerable saving in fuel, depending of course on the quantity of the ash and fuel.

The quality of the ash is such as cannot be produced in any hand furnace, and for the manufacturer of soda crystals the furnace will prove itself a positive boon, as the proportion of caustic soda in the ash finished in the "Mactear" furnace can easily be reduced to ·25 of one per cent. against, say, 2 per cent. in ash from same quality of salts finished in hand furnaces, and the further fact that the oxide of iron seems to be so thoroughly shrunk as to settle very easily, and give liquors which produce the most brilliant crystal soda and the highest grade of alkali from the mother liquors.

The management of the fire and the speed of the furnace must of course be carefully attended to, so as to oxidise the sulphides, &c., and carbonate the caustic soda, as well as to burn off the organic matter in the shortest possible time.

The progress of the action which takes place in the furnace is shown in the following table of analysis, the samples being taken each half-hour during the working of a charge, and are all calculated on 100 of available alkali:—

TABLE VI.

No.	Hour.		$Na\,HO$	$Na\,Cl$	$Na_2\,S_2\,O_3$	$Na_2\,So_3$	$Na_2\,So_4$	Total $Na\ \ O_3$	$Na_2\,S$	Remarks.
	min.	sec.								
1.	3	0	15·17	3·26	2·87	2·12	3·88	13·33	1·0406	Wet salts.
2.	3	30	13·25	3·29	4·69	0·53	3·81	13·33	0·2582 0.10757	Charging completed, still wet.
3.	4	0	11·20	3·18	4·60	1·00	3·80	13·48	0·0965	Damp.
4.	4	30	5·40	3·28	0·86	3·75	7·31	13·43	0·06308	Dry.
5.	5	0	2·87	3·28	0·72	1·44	10·37	13·38	0·0313	Quite dry.
6.	5	30	1·90	3·28	0·59	0·23	12·03	13·42	0·0126	Nearly red hot.
7.	6	0	1·75	3·29	0·19	0·04	12·93	13·48	trace	Red hot.
8.	6	30	1·61	3·28	nil	0·04	13·39	13·48	nil	"
9.	7	0	1·46	3·28	nil	0·04	13·40	13·49	nil	"
10.	7	30	1·31	3·28	nil	0·04	13·45	13·45	nil	"
11.	8	0	1·31	3·28	nil	0·04	13·45	13·45	nil	"

The "salts" chosen for the above experiment were of a very low grade, so as to enable the action in the face to be the more clearly traced; and this accounts for the comparatively high proportion of the caustic soda.

The first experimental furnace was erected in July, 1876, and the success of the machine may be judged of by the fact that there are now at work or erecting some thirty of these furnaces.

Their advantages may be summed up thus:

1st. A saving of about 60 per cent. in cost of labour.

2nd. A saving of about 30 per cent. of fuel.

3rd. Much less supervision is required as the charges come at comparatively long intervals of time.

4th. A much improved quality of ash is obtained from any given quality of "salts."

5th. Great advantage in the manufacture of soda crystals, from the complete carbonating of the ash.

6th. The density of the ash is much increased, and results in a saving in casks to the extent of nearly 10 per cent.

7th. The employment of unskilled labour, as little training is required.

Although specially designed, in the first instance, for the purposes of the alkali manufacture, the "Mactear" furnace is equally suitable for many other operations, such as the calcination of chrome ores with lime in the bichromate of potash manufacture, for drying and calcining operations generally, and specially for the furnace operation, in the extraction of copper from weak ores by the wet process.

f. Production of Caustic Soda.

I would here wish to call your attention to the specimens of caustic soda which are on the table. These are made by a special process, introduced by me for the production of caustic soda of specially high degree of purity. The specimens before you are from the drums, as packed for sale, and range up to 77 per cent. of alkali, English test. The cream, or unfused specimen, is of 70 per cent. All of these have been produced from that *bête noir* of alkali manufactures, the "red liquors," which drain from the soda

salts, and which have otherwise been found so difficult to deal with, and which, with the increasing demand for high strength soda-ash, are becoming more and more a source of trouble to the alkali manufacturer, many of whom still boil them down and re-furnace the "red salts" with the sulphate of soda, while others manufacture from them the common quality of cream caustic soda.

Group IV.—The Utilisation of the Hydrochloric Acid produced in Group II.

This will be best considered in connection with the following group.

Group V.—The Utilisation of the so-called Residual Products.

a.—Regeneration of the Manganese Compounds employed in the production of Chlorine.

The success of Mr. Weldon in solving this problem has left but little hope of improvement in this direction, and with his highly successful process for the regeneration of the manganese you are no doubt all familiar.

b.—Regeneration of the Sulphur from the Alkali Waste, or Sulphide of Calcium, produced in Group II.

The greatest objection urged against the process of alkali making associated with the name of Leblanc, has been that the two primary raw materials, sulphur and carbonate of lime, are both lost as waste products; and not only are they lost, but they give rise to a refuse or waste material which, from a public and hygienic point of view, is of the most objectionable character.

That this objection still exists is not due to any want of appreciation of the facts by manufacturing chemists, but because of the highly difficult nature of the problem to be solved. The subject of the regeneration of the sulphur has indeed been a fertile field of research, almost every chemist, even remotely connected with the alkali manufacture, having, at one period or other of his career, attempted to solve it, although in nearly every case with but scant success; amongst these the late Mr. Gossage, as he himself described it, "had devoted thirty years of his life, and a fortune," to the pursuit of the solution of this problem.

The general tendency of invention has been in two directions:—

1st. Towards the production and subsequent utilisation of sulphuretted hydrogen from the alkali waste.

2nd. Towards the production of hypo-sulphite from the sulphur compounds of the waste.

This ultimately leading to the production of sulphur from mixtures of sulphides and hyposulphites, by decomposition with hydrochloric acid.

The following have suggested processes for the regeneration of sulphur:—Gossage, Delamaure, Kopp, Losh, Noble, Favre, Spencer, Townsend and Walker, Mond, Guckelberger, Leighton, Schaffner, Hoffman, Fowler, Duclos, Blair and Watson, Hills, J. L. Bell, Jullion, Mactear, and others.

Of all these processes, only four, those of Mond, Schaffner, Hoffman, and Mactear, have been worked on anything like a large scale with success, the first and last of these being by far the most successful. The process of Mr. Mond has been adopted by a number of firms in this country with considerable success. Briefly stated, his process (to which that of Schaffner is very similar) deals with the waste produced in the manufacture of alkali, in promoting the partial oxidation of the sulphur calcium compounds by forcing air through a mass of waste; then washing out the soluble compounds thus formed, and decomposing with hydrochloric acid.

The "Mactear processes" (for there are several modifications) owe their origin to the existence of a gigantic nuisance, caused by the natural oxidation of the enormous heaps of alkali waste at the St. Rollox Works; these have been accumulating for more than half a century, and have been chiefly deposited on the surface of an old "peat moss" or "bog," which lies in a natural basin of sandstone rock. The soluble compounds thus formed are lixiviated by the rainfall, and the water from the numerous springs which rise under the waste heaps, give rise to a large flow of what is well known as "yellow liquor," which is a complex sulphide of calcium, holding sulphur also in solution.

This liquid was for many years allowed to run away, and flow with the natural drainage of the land into a brook, called the "Pinkston Burn," which, after traversing a considerable portion of the city as a covered sewer, falls into the River Kelvin at a short distance above its junction with the Clyde. This brook in its course receives liquid refuse of all sorts, other than mere sewage, notably, refuse from distilleries, and these being acid, gave off from the sulphide of calcium liquors sulphuretted hydrogen in such quantities as to cause an intolerable nuisance, of which the public had good reason to complain. Skill, time, and money were expended freely to overcome this nuisance, and remove or abate the cause of complaint, and my two predecessors in the management of Messrs. Tennants' works, Messrs. C. T. Dunlop (whose manganese recovery process, and that for the production of bleaching powder from salt and nitrate of soda, are so well known) and John Tennant, used their best endeavours in this direction. An expenditure of many thousand pounds was incurred in driving a series of galleries from a shaft sunk through the sandstone rock to a depth of 40 or 50 ft., with the view of intercepting the springs of water (some of these galleries extending for over 300 yards), and thus draining off a large quantity of water, which was pumped up and run away. This was continued night and day for years, and, no doubt, must have reduced the amount of the "yellow liquor" considerably, but it still existed to the extent of some 30,000 gallons per day.

The damp character of the climate of Glasgow adds greatly to the difficulty in the way of utilising the waste and the prevention of nuisance. The annual amount of rainfall is about 42 inches, and estimating that only one-half or 21 inches passed through the waste, which is of rather a porous nature, there would be, from this cause alone, close upon 1,300 gallons per acre per day. A long report on the nuisance arising from the drainage liquors was prepared by the late Professor Anderson, of Glasgow University, in 1865, for the Clyde Trustees, which contains much interesting information. Year after year more and more pressure

was brought to bear on my firm, in order to force us to remove or abate the nuisance, and I think the result shows clearly enough the effect of a little judicious compulsion in stimulating invention, as this recovery of sulphur, undertaken at first with the sole object of reducing the cause of complaint of nuisance to the citizens of Glasgow, with little hope of its paying even its costs, has now proved itself to be, when worked with the "Mactear" process, a very remunerative branch of manufacture. It is here worth considering one of the great difficulties to be dealt with in connection with the question of nuisance from alkali waste; it is this:—The drainage comes chiefly from heaps of waste that have been deposited for a length of time, not from the fresh waste, so that, if the demand of the public that such works should be abolished or forced to remove were complied with, the waste heaps would still remain, and continue for a long series of years to be a constant source of nuisance from their drainage; whereas, so long as an alkali works continues in operation it produces hydrochloric acid, and can utilise the drainage liquors which cause the nuisance; and thus the most sure way of removing the nuisance, paradoxical as it may seem, is by encouraging the alkali works to remain in operation, and to undertake regeneration of the sulphur.

In the year 1867, my firm erected plant to work the sulphur recovery process of Mr. Mond, on a modified system, in which the drainage liquors were employed in lixiviating the waste, after its oxidation in the vats, by the forcing through of air. So far as the production of sulphur was concerned this process succeeded sufficiently well, but it had two grave defects for our purposes; there was given off a considerable amount of sulphuretted hydrogen, both in the oxidising process and also in the decomposing operation, when the liquors were not exactly of the correct composition for decomposition. This, on the large scale on which the process was worked at St. Rollox, caused very serious complaints in the immediate neighbourhood of the works, which are almost surrounded by dwelling-houses. The very large amount of plant also, and the fact that it was not found possible by this process to work up all the drainage liquors, caused me to again study the subject more carefully in all its bearings, and after a long series of experiments—many of them, like those of former workers in the same direction, failures—I succeeded in developing the processes which have been so successfully worked at St. Rollox.

The principle of all the processes for the recovery of sulphur from alkali waste lies in the mutual decomposition of sulphuretted hydrogen and sulphurous acid.

The "Mactear" processes have three modifications, each of which is applicable under special circumstances:—

1st. The drainage liquor, usually called yellow liquor, is mixed with a small proportion of lime, and then treated with sulphurous acid, which it absorbs, with the production of a small quantity of precipitated sulphur. The liquid containing this sulphur is then decomposed at about 140 deg. Fahr. with hydrochloric acid.

The objection to this modification is that although it gives good results, it is difficult to regulate the composition of the liquors, and there is apt to be an evolution of sulphuretted hydrogen.

2nd. By the combustion of pyrites, or the refuse sulphur from the process, a solution of sulphurous acid in water is produced, condensing towers built of wood being employed (the wood of these towers, after five years use, seems at this date almost as fresh and good as when new); these are filled with coke, down which a stream of water passes.

The solution of sulphurous acid is led by means of runs to the decomposing vessels, and on its way is mixed with a stream of the yellow liquor, or sulphide of calcium; the mixed liquids run into the decomposing vessel, where they are mixed with a stream of hydrochloric acid, the whole being kept as nearly as possible at about 145° Fahr. With moderate care, little sulphuretted hydrogen is evolved, and a few simple tests easily employed by the workmen enable them to regulate the decomposition with great nicety.

The sulphur is run into draining vessels, and when drained sufficiently is transferred to a melting vessel, where it is melted by steam, and, should it be required, the arsenic removed by the method (first applied at St. Rollox in 1869) of dissolving out the sulphide of arsenic by an alkaline sulphide.

The plant required is very simple, and, when the results obtained are considered, is very inexpensive. A plant to produce 30 to 35 tons per week from drainage liquors of about 11° Twaddel can be erected for about £2,000.

The cost of producing one ton of sulphur by this process is about 61s. This does not include any cost for the hydrochloric acid. Comparing the results obtained by the "Mactear" process with those of the manufacture of bleaching powder, and taking one ton of sulphur to require for its production the acid of 36 cwts. of salt, while one ton of bleaching powder requires the acid from 55 cwts., and if we also take the cost of one ton of sulphur to be 60s., and that of bleaching powder 90s. per ton, we have for the present time the comparison:—

	Cost. £ s. d.	Selling Price. £ s. d.	Margin. £ s. d.
Bleaching Powder ..	4 10 0	5 5 0	0 15 0
Sulphur	3 0 0	5 10 0	2 10 0

or, for each ton of salt decomposed the margin will be, say, sulphur, 27s. 6d.; bleaching powder, 5s. 6d.; a difference in favour of the manufacturer of sulphur of 22s. per ton of salt employed to produce the hydrochloric acid required. Of course, these figures must be modified from time to time with the cost and selling prices of the two products.

3rd. The third modification of the "Mactear" process is that which will in all probability be most widely adopted. It is best adapted for use where the drainage liquors are very weak in strength or small in amount. It consists in obtaining a stronger solution of sulphurous acid by the production of a bisulphite of lime, or at least, of a solution of lime in sulphurous acid. As the old waste, which has become oxidised by exposure to the air, contains large quantities of sulphite of lime, it is utilised in this modification by grinding it into a milk with water (or yellow liquor), and treating this with sulphurous acid; we thus obtain a solution of sulphite of lime in sul-

phurous acid, gaining the sulphurous acid of the old waste, and reducing the amount of sulphur to be burnt for the production of the necessary sulphurous acid. It is in some cases preferable to use the fresh waste, and in this case it is mixed with water or yellow liquor to a milk, and heated with sulphurous acid, the resulting solution consisting chiefly of sulphite of lime in excess of sulphurous acid, and a little separated sulphur, together with impurities, such as sand, carbonaceous matter, sulphate of lime, &c.

This solution, settled from the insoluble matter, is decomposed with yellow liquor and hydrochloric acid, as previously described, or the milky solution of the waste may be treated with the sulphurous acid in such a way as to yield liquors which will decompose directly, without the addition of yellow liquor.

The varying circumstances and requirements of each case may necessitate modification, but the principle of the processes renders them easily adaptable to very diverse conditions, and its success may be assured in every case where its application is undertaken with appreciative intelligence. My practical experience of the regeneration of sulphur from alkali waste extends over ten years, and a production of more than ten thousand tons of sulphur, and, I think, entitles me sufficiently to give an opinion upon the subject. I am certain that, ere long, alkali manufacturers will be compelled, by public opinion (and greatly to their own advantage), to prevent the drainage of alkali waste flowing into the streams and polluting the rivers, and that the general adoption of some form of sulphur recovery is only a question of time.

There can be no doubt that the application of one form or other of the "Mactear" processes to the drainage from the waste heaps at the great centres of the alkali manufacture would very greatly reduce the nuisance complained of in these districts. Were, for instance, a combination of manufacturers along the course of the celebrated Sandy Brook, to collect the drainage liquors which now renders it such a nuisance, pump them to a convenient point, and then treat them by such a process as I have described, I am confident that the results, both pecuniarily and from a hygienic point of view, would be such as to yield ample satisfaction to the sharers in the undertaking as well as to the public.

DISCUSSION.

The Chairman said that he would like to offer a few remarks upon the inventions—the important discoveries he might call them—which had been described. It was a great thing to have proved, as Mr. Mactear had, that it was not necessary, in the black ash operation, to use limestone in excess. Theoretical chemists had been continually demonstrating by their formulæ that an excess of carbonate of lime was required, and now Mr. Mactear had experimentally demonstrated that such was not the case. Forty years ago, however, at the works with which he (the Chairman) was connected, the amount of limestone used was not so high as that which Mr. Mactear had stated to be customary; the process had been worked at this date with 85 parts of limestone—carefully selected chalk—per 100 parts of sulphate of soda, whereas Mr. Mactear represented the old method of working, as requiring 108 parts per 100 of sulphate; the difference might represent the difference in care which was taken; but he should like to know whether there was any explanation for the increase of the amount of carbonate of lime used during the last few years. Probably, but for the introduction of the large revolving furnaces of the kind which was shown on the diagrams on the wall, it would not be possible to use so little limestone. He (the Chairman) viewed the black ash process as largely one of fluxing; the more successfully this operation could be performed the less excess need be employed of either of the materials used. In the hand furnaces the charge was very thin, and had to be turned over with a paddle, consequently the mixture was not so intimate as in the revolving cylindrical furnaces designed by Mr. Mactear. Mr. Mactear had taught the manufacturers a lesson which they would not be slow to learn; and, probably, even now, where Mr. Mactear's process was not adopted in its entirety, it would be found that a considerable reduction in the amount of the carbonate of lime was made. The introduction of the carbonating furnace known as the Mactear furnace, had been a great success; full value was obtained for any improvement of this process, and the result had completely justified Mr. Mactear's view. With respect to the saving of fuel in the use of these processes, he had found that any fuel saved in the furnace was expended in driving the engine which kept the furnace moving; but this, in reality, was a very insignificant matter. The recovery of the sulphur in the sulphur waste was a very important matter. It was a wretched thing that large quantities of the sulphur imported into this country, both in the form of sulphur and pyrites, and used for the manufacture of soda, should go as a waste product; it was a great advance to be able to use this sulphur over again. He should like to ask Mr. Mactear if his process, which had been described, was applicable to new waste. He understood not. Of course, at St. Rollox, there was an enormous quantity of old waste, which had become a nuisance, and the liquors running from which could be operated upon for some time to come, but it would be an advantage to have a method which would deal with waste just formed. The method for taking the escapes devised and worked by Mr. Mactear was a capital one, and the calculation of the loss, as oil of vitriol, on 100 parts of sulphur used, was very useful; also the calculation of the loss, by observing the diminished proportion of oxygen in the escaping air, as compared with ordinary air, was a happy idea; being so simple, it was somewhat remarkable that it had not been adopted before. The statement of the loss, in the form of a diagram, day by day, was novel, and would probably work well. Mr. Mactear began his paper with a reference to the extraordinary development of the alkali trade, which, if the calculation were based upon the common salt used, had more than doubled itself during the last 10 years, for, in 1852, the amount of salt used was 137,000 tons; in 1862, 254,000 tons; and in 1876, 538,000 tons. He (the Chairman) was very much afraid, however, that when the figures for 1878 were made up, the result would not by any means prove so good; this should be a caution to the Legislature not to interfere unduly with large manufacturing interests. The alkali trade had already been the subject of legislation, the satisfactory condensation of the hydrochloric acid was required by Parliament and Government experts were appointed to see that the process was carried out; but it did not seem expedient that the Legislature should do more at present than had already been done. The success of the Alkali Act of 1863 was due to the fact that the thing required to be done was possible. He was glad to see Mr. Mactear taking the lead in experiments which were as much in the interests of the public as the manufacturers; the using up of the waste meant the prevention of a nuisance. Free scope given to all such manufacturing progress would in reality tend more towards the protection of the public than any legislative restrictions, especially with respect to a trade which was the source of so much national prosperity and wealth.

Mr. Mactear, in the course of his reply, said that, with regard to most of the points mentioned by the

Chairman, he was quite at one with him as to the increase in the quantity of limestone used. He believed it had gradually grown to the proportion in which it was customary to use it from time to time, and, little by little, more limestone was put into the charge to prevent spoiling the balls, as the workmen termed it—that is to say, in reality to prevent any evil arising from their being slightly overburnt. There was no doubt that the mixture of the materials in the Mactear furnace was much more intimate than in the hand furnaces, as it was impossible to keep the men constantly moving the charge in their furnaces. If this were done, the work was found to be too heavy for the men, although the results were correspondingly better. With respect to the utilisation of the "Mactear recovery process," it was quite possible, with a little modification, to use it for the treatment of new "waste."

The Chairman proposed a cordial vote of thanks to Mr. Mactear for his paper, which was carried unanimously, and the proceedings therewith closed.

The paper was illustrated by many diagrams and tables, also some beautiful samples of recovered sulphur were exhibited.

AFRICAN SECTION.

Tuesday, May 14th; Admiral Sir ERASMUS OMMANNEY, C.B., F.R.S., in the chair.

The paper read was—

THE NIGER: PAST, PRESENT, AND FUTURE.

By E. Hutchinson,

Lay Secretary to the Church Missionary Society.

On two previous occasions I have been permitted by the Committee of the African Section to place before meetings of the Section observations upon the development of Eastern Central Africa. Among other things I endeavoured to show that to develope and bring to bear anything approaching to good government, and to seek out, foster, and control existing streams of commerce, was the policy most likely to promote the end in view, and that improved means of transport was one of the first problems to be undertaken and solved.

I also showed that, for Eastern Central Africa, this must be done by foreign enterprise in the construction of roads, because there exist no actual highways save those from the northern and southern ends of the region, the Nile and the Zambesi, both of which are in the hands of countries—Egypt and Portugal—entitled by long possession to the earnings to be made on those important waterways.

The propositions I have laid down as to Eastern apply equally to Western Central Africa, but with this difference in favour of the latter, that four, if not five, great waterways traverse almost the entirety of that region, I mean the Congo, the Gaboon River, the Ogowai, the Niger, the Binue, and the Shary.

The charms and possibilities of the Congo have been set forth to this Section by the gallant young explorer, Cameron; and the still more redoubted traveller, Stanley, will shortly make public his views of the future of the great river, whose course he has in such a marvellous manner followed.

If, however, we accept the principle that it is safer to develop existing streams of commerce than seek to create where they do not exist, and if, moreover, we see that the ultimate benefit is to be reaped by a foreign power, I venture to think that, notwithstanding the romance which has attended the recent explorations of Mr. Stanley and the grand future which may await the Congo, the Niger, at any rate, for English merchants, stands first in importance. It is an available waterway for at least 800 miles, has a growing commerce with this country, and brings us into direct contact with a series of fairly powerful and settled governments in the interior.

I therefore propose to ask your attention while I unfold our subject for the evening—The Niger: Past, Present, and Future.

In looking backwards, our natural limit would seem to be so much of the past as may supply the lesson for the future, and we should be confined to what this century has taught us of the Niger and its regions.

In other words, the results of accurate research alone should be our guide. At the same time, it must be remembered that the remote past of Africa is not a blank, which would-be geographers filled up according to their own imaginations, each making confusion worse confounded. On the contrary, with certain approximation to truth, Ptolemy, A.D. 150; Hindoo geographers of unknown date; Juan de la Cosa, in 1495; Bernhard Silvan, 1511; Diego Homen, 1588; the Antwerp map of 1590; Mercator, in 1630; Vischer and De Witt, 1648; and John Ogilvy, in 1670, laid down some of the principal features of the African continent. But when the advance of science demanded accuracy in cartography, accepting nothing on hearsay, John Arrowsmith, in 1806, wiped the whole out, and presented the African Exploration Society with a map which represents Africa empty, swept, and vacant.

In 1788, the African Association had been established, and put forth a statement of which the following paragraph is worth reading:—

> "Africa stands alone in a geographical view! Penetrated by no inland seas, like the Mediterranean, Baltic, or Hudson's Bay; nor overspread with extensive lakes, like those of North America; nor having in common with the other continents, rivers running from the centre to the extremities; but on the contrary, its regions separated from each other by the least practicable of all boundaries, arid deserts of such formidable extent, as to threaten those who traverse them, with the most horrible of all deaths, that arising from thirst! . . . But the public are not to expect, even under an improved system of African geography, that the interior part of that continent will exhibit an aspect similar to the others; rich in variety; each region assuming a distinct character. On the contrary, it will be meagre and vacant in the extreme. The dreary expanses of desert which often surround the habitable spots, forbid the appearance of the usual proportion of towns; and the paucity of rivers, added to their being either absorbed or evaporated, instead of being conducted in flowing lines to the ocean, will give a singular cast to its hydrography; the direction of their courses being, moreover, equivocal, through the want of that information, which communication with the sea usually affords at a glance."

But the blank so invitingly left by Arrowsmith has been gradually filled up, as far at least as the Niger is concerned, by Mungo Park, Caillie, Den-

ham, Clapperton, Gray, Dochard, the Landers, Barth, Baikie, Overweg, Rolffs, and Mage; while the same service has been performed for the rest of the Continent by a host of travellers, foremost among whom are the familiar names of Burton, Speke, Grant, Van der Decken, Lacerda, Silva da Porto, Livingstone, Cameron, and Stanley.

But the result of all their labours is in reality the re-discovery of a lost Continent. For in its main features the last new map of Africa differs but little from that published by John Ogilvy in 1670, a map evidently taken from the Dutch work of De Witt. It represents the Nile as rising from two lakes south of the equator. The Congo rises from a great lake a little to the north of the Lacustrine system, described by Livingstone, flows north toward the equator, then turns to the west, and falls into the Atlantic. Its course, thus depicted, is almost identical with Stanley's discovery, while the Niger, the origin of whose southern branch is yet undetermined, is represented as a great river issuing from a great lake just to the north of the equator, flowing north to about the latitude of Cape Verd, and then turning to the Atlantic, a combination, in fact, of three rivers, the Senegal, the Quorra, and the Binue or Shary.

When we remember that three great people have had close dealings with the African continent before our time, the Egyptians, the Moors, and the Portuguese, it is natural that we should find some trace of their acquaintance with the interior of the continent, and we may suppose that had they possessed the scientific aid our travellers now employ, the geography, at any rate, of Africa would have been more accurately portrayed.

Of these three nations, none played a more remarkable part at one time than the kingdom of Portugal, and her conquests seemed to place within her grasp a dominion in Africa unrivalled in extent. Its coast line on the west stretched from Cape Lopez just to the south of the equator, to Cape Frio in 18 deg. south latitude, and on the east from Delagoa Bay to Mombasa, and in the words of Captain Burton, in his introduction to the Emperor of the Cazambe—

" * * The Portuguese * * in the sixteenth century, established factories on both coasts, eastern and western; their traders crossed the interior from shore to shore, whilst their missionaries founded large and prosperous colonies, such as Zumbo in the east, and San Salvador in the west, with cathedrals, churches, chapels, and storehouses. The explorers did not neglect either the Lake Regions of Central Intertropical Africa, or even the basin of the Zambesi River."

The geographers of the 15th or 16th centuries whose names I have mentioned, probably derived their information from these Portuguese explorers.

Nevertheless this century has seen probably the re-discovery of the lost continent, and in the mighty territory which lay within the grasp of Portugal there now remains nothing to tell of the beneficent sway of a power which might have been the Great Britain of its day, save Indian corn and tobacco found almost everywhere in tropical Africa.

So much for the lesson which connects itself with the remote past of the Niger. I have introduced it here, to point that moral which the Society of Arts seeks to inculcate.

The more recent history of explorations connected with the Niger, is so well condensed in Mr. Keith Johnston's admirable work on Africa, and in a paper by the Right Rev. the native Bishop of the Niger, that I quote from them the following:—

"One of the largest African rivers, the Niger, is unquestionably the most important in the west. Rising, it is believed, at a distance of about 200 miles east-north-east of Sierra Leone, the Joliba or Upper Niger flows first north-eastward towards Timbuktu, thus reaching the Sahara and the domain of the Tuareg. Here, after flowing for some distance in a due easterly direction, it suddenly changes to the south-east, and at last reach the ocean at its delta. During its upper course it bears the name of the Joliba, and that of the Quorra or Kuarra in its middle or lower. Although the river was known vaguely by report to the ancient geographers, and supposed by Herodotus to be a branch of the Egyptian Nile, and though trading vessels had long been visiting the creeks at its mouths, no definite notion of the Niger began to be formed till Mungo Park first reached it from the west coast, and found it flowing slowly to the eastward through the kingdom of Bambarra, with a width nearly equal to that of the Thames at Westminster. In his second journey of 1805, convinced that the river must have an outlet in the sea, he was on his way down it in a canoe, when he was either murdered or drowned in sailing through a narrow channel of the stream at Bussa, in the kingdom of Gando (10° 20′ N.). In 1825, Caillié descended the river from Jenne to Timbuktu, in company with a cargo of slaves in one of the fragile native canoes, which keep up a continually active trade along the whole extent of the river; in 1830 the brothers Lander, one of whom had accompanied Clapperton in his unsuccessful journey of 1826, landed at Badagry, and, marching overland to Bussa, took canoe there, came swiftly down the great river with the autumn floods, and arrived at the Nun mouth, thus settling the long-vexed question of its outlet. Several heroic attempts were now made to open up the new-found highway to legitimate trade, and to abolish the slave traffic by it; first, the ill-fated ascent of the river by Macgregor Laird, in 1832, with two small steamers; and then the expedition sent out in three vessels by the British Government in 1841, which founded a "model farm" on a tract of land at Lukoja, opposite the confluence of the Binue and Niger. Such, however, was the fearful mortality among the Europeans sent thither, that the Niger schemes were abandoned till 1852, when Mr. Laird established the African Steamship Company, and built factories along various points of the river."

"In 1854, the Government were induced, by the urgent representations of the late Macgregor Laird, to attempt another expedition, and one was sent in 1854, under the command of the late Doctor Baikie, to explore the Tshadda Branch, from the confluence of this and the Kwora, which, after staying in the river 118 days, returned without the loss of a man, precautions having been taken to avoid putting into the bunkers green wood, the noxious vapour of which was supposed to have been injurious to the health of the members of the expedition of 1841.

"A very interesting exploration was at that time made of the Tshadda Branch, in the course of which the expedition succeeded in reaching the town of Hamarua, a distance of some 400 miles to the east of the confluence.

"The success of that expedition induced the Admiralty to enter into a contract with Mr. Laird to explore the Niger and its tributaries, and in 1857 an expedition was sent out under the command of the late Dr. Baikie, when Lieutenant Glover, now Sir John Glover, drew the chart of the Niger now in use, but the progress of this expedition was impeded by the wreck of the steam-ship *Dayspring* on a rock above Rabba, about 200 miles from

the confluence. Bishop Crowther says, 'since that time I have been, I may say, almost every year able to visit the Niger, sometimes in the expeditions of the Admiralty, and when they ceased, in the various trading steamers which now, to the number of five or six, make the annual ascent of the river. During this time I have had, as may be supposed, many varied opportunities of becoming acquainted with the geographical features, not only of the river Niger itself, but also of the countries which lie adjacent to it on either bank. I have twice marched from the Niger at Rabbah and Bida, to the sea coast at Lagos, and I have endeavoured to gather such information as I could, as to the peoples, their habits, languages, and races, and also as to the chief directions of the trade from and to the interior of the countries which lie to the east of the Quarra, and to the north and south of the Tshadda Branches.'

"Two very marked divisions at once present themselves in endeavouring to give a description of the Niger and its adjacent countries, and these are the upper and lower Niger, or to speak more correctly, the delta of the river, and its course through the main land. What the actual extent of the delta of the Niger is remains at present unknown, whether the Old Calabar River with its affluents form any portion of the delta is uncertain. But still it is not improbable that there is a communication between the Tshadda and Cross River, explored by the late Mr. Beacroft; at any rate, it is remarkable that the Akpah tribes of Adamawa, seem to have found their way down to Fernando Po by some short cut. But to the west there is no doubt that the vast system of marsh and lagoon, which reaches as far as Porto Novo, to the west of Lagos, is more or less connected with the delta of the river, though they also owe their existence to the smaller streams, which also pour their mud-charged waters down from the higher levels of the Yoruba country. Thus, what may be called the delta of the Niger, is a vast tract of marshy country extending along a coast line of some 120 miles, with a depth to the interior of about 150 miles at the broadest part.

"The recent explorations, begun by Sir John Glover and Captain Goldsworthy, and followed up by the Revs. Messrs. Maser and Roper, of the Church Missionary Society, have made us acquainted with the characteristics of the western portion of the Niger delta, and have showed us that, as regards the feature of the land, there prevails a monotonous uniformity of intricate canal and marsh, villages hidden in the dense growth of reeds, the people partaking of all the characteristics of the dwellers in African swamps, and all, as far as it was possible to to ascertain, speaking, even up to Benin, with slight modification, the Yoruba language, the same as is spoken at Badagry, Abbeokuta, Ilorin, and Ibadan."

Good descriptions of the river are to be found in the works of Captain Allen, Dr. Baicke, and in a more recent publication by Mr. Whitford. Captain Allen says:—

"The Rio Nun, the chief entrance, from its size, has the appearance of an estuary, being more than a mile and a half wide and five miles in length; the other outlets resemble this. The water is deep in every part of it. The rise and fall at spring-tides is 5 ft. 6 in., and at neaps 4 ft. 8 in. The ebb-tide sets out with a velocity of three miles and three-quarters or four miles in the middle of the river.

"The opposite sides of the river appear to be of different formation. Cape Nun, the termination of the right bank, has a long spit of sand running into the sea about one mile and a half. The shore of the right bank is generally swampy, formed by a deposit of mud, brought down by the river, the outside of which presents a sandy appearance; and is intersected by innumerable channels of water, of a brackish and putrid taste. Where dry spots are found, they are cultivated by the natives from the other side. The bed of the river is covered with a blue clay, rich in vegetable matter, and coloured by oxide of iron, similar to the clay observed in the bed of the sea outside the bar. Whenever the clay was broken by the rapidity of the current, the pieces were immediately carried off by the moving water; and it often happened that the spring tides washed them ashore, in the shape of cylinders. These being left behind by the retreating ocean, formed one of the peculiar characters of the right bank of the river.

"Passing through a narrow channel, it expands to a wide sheet of water, with many islets, and several broad and promising channels on the right and left. Nothing at this part was to be seen indicative of anything like *terra-firma*, the visible boundaries of the river in all these branches being an endless confusion of the arching roots of the mangrove, the only occupant of this swamp. At low water, their roots are covered by slimy and stinking mud, with decayed vegetable matter; to which may, not unreasonably, be attributed the deadly character of the locality.

"The Nun branch, soon after leaving Louis Creek, was scarcely one hundred and twenty yards wide, but on advancing, we passed several divergents, and the width and depth increased proportionally, as well as the strength of the current.

"The banks began gradually to assume the appearance of firmer land; at first without any vestiges of the operations of man; but soon some small cultivated patches were seen, bearing plantains, a few fishing stakes, and a small fishing hut, &c. The universal stillness of the scene was very imposing, unbroken as it was by any sound, save the dashing of our own paddle-wheels, and the clear musical cry of the leadsman, which aided the effect, falling on the ear in measured cadence. The large and umbrageous trees, with their festoons of *Orchideæ* and purple and white *Convolvuli* hanging from the branches, formed a combination of forest scenery so striking, novel, and interesting, as enabled us to forget that much talked-of delta of the Niger had been fairly entered upon. The reeds gave place more frequently to patches of cultivation, in the midst of which were small granaries, raised from the ground on poles, to secure the stored productions of the soil from the overflowing of the river, as well as other more cunning depredators, as the proprietor lives in a distant village. Sunday Island—twenty miles from the sea—is the highest point to which the sea-tide reaches in the dry season, clearly indicated by the gradual but rapid disappearance of the mangrove trees.

"Ferns, the *Ficus*, *Mimosæ*, and various shrubs and bushes of small growth increase above Sunday Island; and the banks, which previously were swampy, become somewhat firm; and the eye—wearied by the melancholy and monotonous hue of the mangrove—is delighted to witness the rapidly increasing vegetation, which soon assumes all the dignity of the tropical forest.

"A few fishing-stakes and some small patches of plantains give the earliest indications of approach to the habitations of man. The first villages are composed of a very few mud huts, of a square or oblong form, with thatched roofs and gable ends.

"At about 65 and 75 miles from the mouth of the main stream there are two important branch outlets, the first flowing to the west, called the Wari branch, finding its way into the western portion of the delta; and it is believed that the Niger might be reached by means of this branch, from the Lagoons at Lagos. The second outlet leaves the Niger at Ndoni, and from what I have heard at Bonny, I have good reason to believe it communicates with the outlets called the Bonny and New Calabar Rivers. Both these important outlets are closed by the jealousy of the tribes on the river.

"The Warree Branch was called the Benin by Lander, because by it the town of Benin may be reached. This branch has been explored recently by the steamers of the West African Company which reached the river.

"It is also supposed that from the Ndoni Branch there

is a connection with the river Jumna, or the old Calabar or Cross River, explored by Beacroft in 1841.

"Up to these points the Niger flows between low clay banks; the whole country around is flat and swampy, Here, however, at some little distance from the stream. gently rising hills are seen on either side, indicating that we have passed the delta proper, and are now entering on the main stream of the river. The character of the river here changes; instead of the numerous and rapid windings of the lower reaches, its course is nearly straight, and the breadth is about a mile and a half. At this point, also, a change in the character of the people takes place. On the eastern side of the main stream they are, almost from the mouth of the Ibo or Idzo, tribes entirely pagan, with various forms of idol and fetish worship, two marked features being the idea of sacrifice, ordinary victims being domestic animals, and on special occasions single human beings, but with no such indiscriminate slaughter as at Dahomey or in Ashanti."

Onitsha, the Ibo capital, lies on the eastern bank of the river. It is a place of much importance for trade. The following account is furnished by the Rev. H. Johnson, who visited it last year:—

"Onitsha, in many respects is the most important station on the Niger.

"Whether as regards religious or mercantile affairs, it may be looked upon as flourishing. To a newly arrived person, whose vision is not jaundiced by prejudice, it is calculated to give a good impression—one that cannot but be enhanced by contrast with the disheartening features apparent everywhere in the lower stations. As the steamer came up, denso crowds assembled to welcome its arrival.

. . . .

"On Monday, 15th October, we accompanied the Consul once more to the palace, to witness the signing of a treaty between her Majesty's Government on the one hand, and the king and chiefs of Onitsha on the other. The Consul was resplendent in his official dress, and being attended by the Bishop, the entire body of the Mission agents, and representatives of the three mercantile houses here, there was hardly anything wanting to give due importance to the occasion. We had not long been seated, when the jingling of a bell announced his Majesty's approach. He came and threw himself down on his seat with an air of nonchalance, adjusted the scanty piece of cloth round his person, looked about defiantly as "who should say am I not a mighty potentate," and then nodded salutation to his visitors. This done, the senior chief present rose up, and standing before the king, offered the usual obeisance in the name of all the subjects. He performed all sorts of strange gymnastics, shaking his fist the while at the king. I was rather confounded by this threatening attitude assumed by one of the king's principal subjects, but it was soon explained to me that shaking the fist at anyone was a mode of salutation, implying, 'I hope you are as strong as my fist and arm.' On resuming his seat, the chiefs of secondary rank came forward and performed. Then followed troops of young men who prostrated, touching the earth two or three times with their foreheads, and retreated. Last of all came the children turning somersaults, and making other ridiculous antics, to our intense amusement.

"All this occupied but a few minutes, and then, all being seated, and silence having been proclaimed, the palaver began. The Consul read, and the Rev. W. Romaine interpreted, clause by clause of the treaty. It was curious to see how "vested interests" were jealously guarded by even these simple-mindod natives. Every clause was turned and twisted about and nibbled at before it was reluctantly agreed to.

. . . .

"All being agreed to, then came the work of signing the Treaty. With the greatest difficulty could the king and chiefs present be brought to touch the pen. They attached to the act some superstition or other, and were afraid of some awful consequences, which nobody, themselves included, knew of. After much pulling and hauling, the documents were duly signed; one was left with the King, and the other taken away by the Consul. Presents after their liking were presented to the authorities, and then each one tried to find his way home as best he could in a very dark night, and under high bushes.

"The town of Adda-Mugu to the north of Onitsha is the point also where a new territory—that of Igara—begins. This was the town of that Abokko who was so friendly to the traveller Lander; and his sons, or kinsmen, are chiefs of the country up as far as the confluence.

"At Adda-Mugu, also, the character of the dwellings changes. Here, for the first time, are seen the circular conical roofed huts, which prevail in the interior; the dwellings up to this point are the usual square or oblong low huts.

"About forty miles above Adda-Mugu is the town of Iddah. The river here flows through a low chain of hills formed of red sandstone, and the cliffs of this material on either side of the river are an entirely new feature in the river scenery. They rise to the height of 185 feet, on the summit are the conical huts of part of the town. From the summit a splendid view is obtained; to the north and south the river is seen extending for many miles, while on the western there is seen an undulating country, bounded on the far west by the mountains of the Yoruba country. The town of Iddah, the largest and most important in the kingdom of Igara, is built on the summit of the cliff on the east bank of the river. There are about 2,000 huts and about 8,000 inhabitants. Nearly all the dwellings are the usual circular huts; the walls rise about six feet, and are built of clay and stone; the roof is conical and thatched with palm leaves. It is generally supported in the centre by a pole or wooden pillar. The eaves of the roof form a low verandah. When there is a door, it is carved in an elaborate manner, with a rude sketch of an alligator or some other animal; the fastening is a bolt and a rough padlock; these are, however, seldom required. The furniture and utensils are few, and generally lying about the court, such as large earthenware jars for water. The cooking apparatus are small calabashes and earthen pots of various forms.

"The streets are very irregular and numerous; the principal market is held on a clear level space, shaded by numerous trees. It is arranged according to the directions of the chiefs, all articles being properly classed and exposed for sale on the ground, or on mats. There was a great variety of vegetables, yams, ground-nuts, palm-nuts, cassada, kola-nuts, plantains, Indian corn, sugar-cane, cocoa-nuts, rice, shea butter, calabash pumpkins; various native manufactures of cotton, for tobes and body clothes; red and blue cotton and grass threads, raw cotton of very short staple; native made swords, knives, spears, and little calabashes of dye powders, oxides of iron and camwood, as also brass and ivory ornaments for the body, and pipes of clay, or iron, very neatly made.

"The most common manufacture is that of cotton cloths, practised by a great number of females. In spinning, the primitive distaff is used, such as is usually seen in Italy, or in some of our own mountain districts, where the spinning wheel is not always obtainable. The thread is rough and uneven, but when carefully woven into narrow stripes by a rude machine—very like the earliest of our hand-looms—it forms a strong and durable cloth, much dearer than the English cottons brought there, and, of course, only within reach of wealthy people.

"After leaving Iddah, the river continues to flow between sandstone cliffs and sloping banks, behind which are table-lands and gently rising hills. In about forty miles another region seems to be reached. Large rocks

of quartz are seen, and the mountains on the eastern side are steep and conical. Down their sides are deep ravines which, in the rainy season, are mountain torrents. Continuing to the north the mountains close in upon the river, until at last the confluence is reached, the junction of the two rivers, Quorra and Binue."

Dr. Baikie thus describes the scene from Mount Patteh, opposite the confluence:—

"Flowing from our left, and meandering round the base of the chain of hills on which we stood, came the narrow Quorra, while full before us came journeying from the eastward the broad straight-coursed Binue, the mingling waters of the two mighty streams forming the lake-like confluence, its surface dotted with islets and banks, or rippled by contending currents, while in the distance on the right the united rivers rushed impetuously to the sea through the deep defile by which we had ascended.

"Along the banks numerous villages could be discerned. Far as the eye could reach, for miles and miles, the ground teemed with the exuberant vegetation. Such a fruitful soil in other climes, and with a happier population, would yield support and employment to thousands, and, long ere this, have proved the source of untold wealth. The peninsula formed by the junction of the two rivers is a miniature delta, low, swampy, and intersected by numerous streamlets. The natives fancy there is a difference in the colour of the two streams, and call the Quorra the white water, while the Binue is known as the black water."

Lokoja is a town at the confluence. Mr. Johnson says:—

"On Thursday, September 6th, at 4 p.m., we arrived at the important station of Lokoja, beautifully situated at the confluence of tho Niger and Binue rivers. As at other places, the news of the arrival of a steamer soon brought half of the population down to the water's edge, the colour and variety of whose costumes gave just grounds for many critical remarks. I was struck, at the first view, with the difference between the people of this place and those in the lower part of the river. The former have attained to a degree of civilisation which contrasts very favourably with the almost total absence of it among the latter. Nude bodies are here the exception, and not the rule. A glance, too, was sufficient to show that Mahommedanism held sway. Flowing tobes and turbaned heads issued from every quarter. But let me crave pardon to say that to nickname the inhabitants as 'the Great Unsoaped,' would do them no injustice whatever. The tobes were red with the dirt and dust of years. It is said that from the time when they are put on new, to the time when they become so threadbare as to be unfit for any further use, they are never dipped in water. The smell of musk (with which these tobes are besmeared), is agreeable to their olfactory nerves, and they are afraid lest the superstition of washing might deprive them of that delicious odour! The Koran speaks of a river in Paradise (Salsabeel), being perfumed with the smell of musk; no wonder then that 'the Faithful' in this part of the world are so fond of that particular odour.

"Having spent four days at Lokoja, I had sufficient time to form to form an idea of the proficiency of the Mahommedans there in Arabic. The result of my inquiries was, that their knowledge of Arabic was ridiculously meagre. If I except one of the priests, I did not come across a single person with any decent idea of reading. The priest I have alluded to has compiled a history of the Nupe Country, in Arabic, part of which he gave to the bishop. I have not yet seen the copy; when I do I shall try to make it out to see whether it be of any literary value. There was a man with whom I spoke Arabic, but he hailed from Waday, and his was a vulgar dialect, spoken quite independently of grammar. However, I was able to make out his meaning. The few who attempted to read out of my Koran managed but indifferently. Unless I made the beginning, they could not open anywhere and go on by themselves. They professed to be unused to a printed copy, and said their lack of fluency arose from the fact that mine was so."

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Mr. Johnson also visited Egan, the great ivory market town, distant from Lokoja about ninety miles. He says:—

"In going up we could not do the whole distance in a day, owing to the strength of the current; but on our return we glided smoothly down in seven and a-half hours. The country through which we passed was beautifully diversified. The scenery in many parts was bold, and rich table-lands extended as far as the naked eye could discern. All the way from the Nun there is nowhere a larger population. The houses at Egan are built with conical tops, and so near each other as to make you think, when at a distance, that there is no space between them. The number of inhabitants (exclusive of strangers) is variously estimated at from 8 to 10,000. As applied to Egan, that saying is true—'distance lends enchantment to the view.' No one could look at the factories, with their galvanised iron sheet coverings—the steamers moored beside the house of each firm—and the river and creeks covered with a countless number of canoes plying about with articles of merchandise, or conveying passengers from one section of the island to the other, without congratulating himself that he was approaching a town with a higher type of civilisation than he had yet met with since leaving the coast. But, alas! cultivating a closer acquaintance with Egan, you are reminded of another proverb, equally true—'all that glitters is not gold.' There are no streets, but narrow crooked lanes, some leading no where. Walking out, we took by mistake a wrong turning, and not until we were on the point of invading the sanctity of a private dwelling-house, did we know that we had left the right track. Refuse of all kinds is shot into the streets. Can you wonder, then, that all the senses are offended at once whenever you would take your walks abroad? It is wonderful that people could live and thrive in this fœtid atmosphere; but such is the nature of habit, that after residing here for a certain period of time, even those who were originally born and bred in the purest atmosphere seem utterly insensible of the malarious poison which floats about them continually. I used to think that houses could hardly be built more close to each other than they are in certain quarters of Lagos; but the architects of Egan are far more skilful and more economical of space. I believe that it is possible to traverse the town by leaping from one house-top to the other, but for the shape of the roofs. These are the physical drawbacks: but the merchant can risk anything—life itself—to make money. And he does make money at Egan, The mercantile houses here make together several thousands of pounds annually, by their trade in ivory and shea-butter. Who can say that that is not worth a consideration? And it seems that the trade is capable of unlimited development. Whereas at the beginning only five casks of shea-butter could be had at this market (*teste* Bishop Crowther), now one company alone can easily secure between 300 and 400 casks. Ivory traders have come from Adamawa and other places on the banks of the Binue. Really, no one can tell what amount of trade will be carried on when that river shall have been thrown open to the commercial world.

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"Kipo Hill is our furthest station up the river, and was granted to Bishop Crowther quite recently by the King of Bida, after repeated importunities. Its elevation causes it to be distinctly visible from a great distance. Kipo is most pleasantly situated. Only two years ago it was overrun with long grass and thickets;

but now it has become a desirable habitation. Its elevation, and the fact of there being no villages at the back, ensure for it a pure atmosphere, and nothing hinders it from being made an excellent sanitarium. Over and over did I test its superiority over other parts of the river as a place of residence. Egan enjoys the unenviable reputation of being as hot as an oven. Scarcely a whiff of air blows to cool your panting breath. But, just when you are so tormented with heat, go across to Kipo, and you will there enjoy the delicious breeze that perpetually blows over it from the hills. The native village, from which the hill derived its name, is about a quarter of a mile on the east of it, and the market town of Kasa is a mile beyond that; so that we are almost, but not quite solitary. But this is a wonderful country for villages and towns springing up with the rapidity of mushrooms. Since our occupation of Kipo-hill, the local governor of Egan has made a most extensive farm on our left, stocked with maize and other marketable products. It took the Bishop, Mr. Paul, and myself about half-an-hour to get from one end of the farm to the other; and I was told that before long we shall have large and flourishing villages beside us. The truth is, that the people long for protection, which, under the present system, they do not enjoy; and they are gradually strengthening themselves in the belief that their safety largely depends upon their making themselves our friends and neighbours.

"An interesting and pertinent illustration of this is to be found in the following story. I must premise that the whole of the Nupe Country is considered as the personal property of the King, who is himself subject to the Sultan of Gondo. The latter monarch, though politically independent of the Sultan of Sokoto, yet yields him precedence, and offers annual presents to him as the elder brother. It is the custom to assign districts and provinces as mensal lands for the support of each of the children of the Sultans; and these princes appoint officers over their possessions to gather the taxes. Some of the officers are a rapacious set, who grind down the people by exacting nearly as much again as the princes may have chosen to impose. Wherever their Highnesses pass, they take away from the inhabitants their hard-earned property; so that their progress through any district very much resembles the ruin caused by a plague of locusts. On such occasions they would never limit themselves to the lands regularly made over to them, but would settle down upon any that lie in their route, and make the most exorbitant requisitions. Once, news came that a son of one of the Sultans was going to Lokoja, *via* Kipo. The villagers in the neighbourhood were frightened out of their wits. Some left their houses entirely, and went to stay in the bush until this tyranny were overpast. The majority, however, brought their beds, cooking utensils, cowries, and all their belongings to our Mission-house for safety, and filled the parlour, bedrooms, piazzas, and garret with their worldly goods ond chattels. Mr. Paul was was away from home, but had left word that the Prince should not be allowed to enter the house, but that his wife was to send him handfuls of kola nuts, the usual token of welcome and goodwill. In due time the Prince came, and Mrs. Paul faithfully observed her husband's directions. He was too polite to take advantage of the absence of the master of the house to force himself in, and so, after gazing about a few minutes and expressing his admiration of the house, he took his departure. The next thing heard of him was, that he had plundered a distant town of all the sheep, fowls, goats, and corn, and compelled the unfortunate inhabitants to provide ever so many bags of cowries.

"It is needless to say that the villagers to whom our premises proved such a refuge in a time of distress were profuse in their thanks, and when I saw them last they were all settled at their homes in peace. When the man who is the governor of the villages, and who had been absent with the king on a war expedition, heard of the conduct of the Annasaras (as we are commonly called) to his people, he was full of joy, and is said to have remarked that he never expected it of us, and that those whom at first they were not pleased to see in their country had turned out their best friends. I need not say that I was glad of the observation. Little incidents of this kind will help to clear the confused vision of the people as to our real character. By being punctual in observing the duties of reciprocity and benevolence—obligations which are scarcely recognized by others in their dealings with them—we shall find a key to their hearts."

Bishop Crowther gives the following description of the Binue River:—

"We found the river, after leaving the confluence, of a considerable breadth, but the channel very tortuous. Here, as also lower down the river, a fresh strong breeze, which always, except during squalls, blows up the river. The scenery daily increased in beauty as we advanced up the stream, until at a point about seventy miles above the confluence, the river presents a noble appearance, far exceeding in breadth any part we had yet seen. The banks are clothed with tall palms and other graceful trees, numerous green islands diversifying the scene, and green hills stand out against the dark mountains in the background. Our vessel drew seven feet of water, and the numerous shoals and sandbanks rendered navigation very difficult.

"The district along the north side of the Binue, as far as we had come, was known by the name of Igbira, its extent being, from the confluence eastward, about fifty miles. The chief town was Pánda, now destroyed, and to distinguish the country and its people from another tribe which I shall hereafter allude to, it is often styled Igbira-Pánda, Igbira-Ihí, or Igbira-Egú. The country has been represented, but wrongly, as being called Pánda, which is properly confined to the town. The people are highly civilised, friendly, civil, and most industrious, and with whom it is of much importance to keep on good terms, as a great deal of trade is carried on by their means. A few Mohammedans are to be found among them, but the great majority are Pagans, but with fewer barbarous rites than any other heathen tribe we encountered. Tattooing is not practised, nor have they any distinctive mark. In person they are rather tall, and well-made, with a sub-typical negro countenance, and they generally keep the body well covered with clothes. They use a peculiar language, differing from the Igára, and having mixed affinities, chiefly with Núpe and Yóruba.

"The country on both banks of the river is covered with forest. Numerous towns and villages are placed along the banks, sometimes visible and sometimes hidden. Some of the scenery was occasionally varied by the appearance of ranges of hills, while in the various reaches of the noble river numerous wooded islands were passed as we ascended.

"Above Ojogo the current ran nearly three knots, the river being for a short distance confined between banks, behind which was finely wooded rising land, where also oil-palms were noted for the last time. Along the river edge, generally partially embedded in the banks, were large, unshapely-looking blocks of rock, bearing evident marks of igneous action. A little further on a fine range of hills ran nearly parallel with the river on the north side, one extremity touching the water. Just beyond the current runs very strongly, averaging four knots, and the river takes a northernly bend. The banks on the south side are very high, and along the top, picturesquely placed nearly at the foot of a table-mountain, we could see a village. Behind we discovered another prettily shaped hill.

"Dr. Baikie, in his narrative of the expedition, says:—'In this beautiful locality, favoured as it seemingly is in situation and in soil, secured by its elevation from

the rising of the river, free from swamps, and abounding in healthy situations, not a trace of a human habitation could be seen, nor was there visible the smallest attempt at cultivation. Many hills near this place have a very peculiar aspect, some being quite isolated and rising with deep sides almost suddenly from flat land near the river. Fresh breezes blowing daily up the stream, we got a spare forecastle awning fitted as a temporary foresail, which sensibly affected our progress. Though no towns or villages could be seen to enliven the prospect, yet everything around us wore a smiling aspect. The river, still upwards of a mile in breadth, preserved its noble appearance, the neighbouring soil teemed with a diversified vegetation, and the frequent recurrence of hill and dale pleased and gratified the eye. Nor was animal life wanting, for from our mast-head we enjoyed the novel sight of a large herd of elephants, upwards of an hundred in number, crossing a little streamlet, not much more than a mile from us.'

"Near this place we came upon a settlement of Fulatas, on the south bank. The district is named Zhibú. and there are three towns: Gándiko, Gankéra, and Ghibu. This settlement originated in a Fulata expedition sent to attack Wukari, a large town on the south bank, but it failed, so instead of returning to the northern shore they founded these towns, and intermarried with the inhabitants of the district, the Djukus. The languages spoken are principally Púlo and Djúku, but Háusa is also understood by many. About one-half of the people are nominal Mohammedans, the remainder being Pagans.

"In these towns the huts are less crowded, and have about them little plots of ground planted with vegetables, being the first signs of horticulture we had met with. On the sides and roofs of the huts were trained pumpkins, gourds, and other cucurbitaceous species, while in their gardens were numerous plants with still unripe fruit. In a little market we found women bartering beer for bundles of corn of different kinds. Hearing that there were horses we asked to see them, and were accordingly shown several fine Arabs, nicely groomed and cared for, and in fine condition. In each stable hung oval-shaped shields, made of elephants' hides, large enough to cover and protect both rider and steed. The possession of horses is one of the distinguishing marks of the Púlo tribes, one, too, which adds greatly to their power and to the terror of their name. Most of the inhabitants were clad in native-made clothes, but some appeared in garments made of goat-skins, while a few wore still more scanty coverings of green leaves.

"Pursuing our course up the river, we come to Zhibù. The town is about a mile from the river, situated on a rising ground, commanding a fine view of the Binue and the country around, and appears to be of greater extent than Idda in Igara, compact and thickly populated. The chief said it would take us eight months to go as far as Hamaruwa, and the river would rise during this month only, and begin to fall the next, and in a little time it would not be deeper than a man's waist, so that our ship being large, would not have water enough for the voyage downwards. When the chief was asked if a bullock could be purchased, he said they had plenty, but they were with their masters. He was asked who these masters were, but gave an evasive answer; but we had learnt from the people that they were slaves of the Filanis, or Foulahs, who came from Yola and Hamaruwa.

"The kinds of grain grown here are maize, or Indian corn, guinea corn, and the straight-headed grain, called gero, and dawuro; rice is grown, but in very small quantity, though thousands of bushels of it might be produced yearly on the irrigated banks of this river, which would supply millions of people with wholesome food. In consequence of the men being chiefly occupied in marauding expeditions, the infirm male and female slaves are generally employed in the cultivation of the soil. No yams, plantains, bananas, cocos, ornges, cocoa-nuts, or pine-apples, are to be obtained—these plants not being cultivated. No eatables are hawked about the streets by girls and women, nor are there any places of refreshment, or eating houses under sheds; in short, there is no market in this country like those met with on the west bank of the Niger. They barter one thing for another, corn for beer, and beer for corn, ground-nuts for rice, &c., but some people took cowries for ivory, to be carried to the Haussa country, where they are current. There is a total absence of palm-trees here, and consequently no palm oil, and soap is a very scarce article. The people, with very few exceptions, are scantily clothed, ragged, and dirty. Clothes are, consequently, in great request; so that, in exchange for fowls, goats, sheep, ducks (of which they possess many), and for mats and corn, they ask cloth.

"About 40 miles from Zhibù, the Binue, after passing through flat and then undulating country, receives its first affluent, which comes from the north. It then becomes extremely narrow, being hemmed in by rising ground, especially on the right side, for about a quarter of a mile. The depth was not less than five fathoms, and the whole volume of the Binue having to pass this narrow gorge, the current became so rapid that it was difficult to stem it. After rounding Lynslager Point, we found the river spread its noble stream over as extensive a bed as before.

"For some distance the river keeps its breadth, but there is plenty of water, from three to four fathoms. A new range of hills showed itself at a great distance on the left side of the river, consisting of many lofty conical mountains. It lay behind a long ridge of high lands, running to a considerable distance, almost parallel with the river, which presented a very picturesque appearance. The tops of some of these mountains are covered with luxuriant woods and jungles, and others are quite bare and rocky.

"About thirty miles further up the river, we came to the town of Zhiru, on the southern bank, and landed; we found this to be another Fulah settlement, as in Gandiko, the conquering race reducing to slavery the aboriginal inhabitants. These are the Akpoh, or Balni Djukus, who are also met at Fernando Po. The old people retain their primitive costume of a few leaves; the younger having learnt from their conqueror to adopt a more becoming style of clothing.

"Pursuing our journey, we anchored off the village of Tshomo, from which the capital town of Hamaruwa is about fourteen miles distant. Hamaruwa is beautifully situated on a hill, rising on the south side of the range of the Muri mountains on the west side of the Binue. It commands a fine and extensive view. The river is seen stretching along like a narrow strip of white cloth, between the shades of light green grass, which fringes the water's edge, and a little further back is the darker green of trees, and then the blue ranges of Fumbina, with the lofty Mauranu mountain in Adamawa, on the left, and the Muri mountain in Hamaruwa, with their many fanciful peaks, on the right side, each at a distance of 12 miles from the river. In the valleys below the town, from 100 to 200 beautiful cattle were feeding, and this gave life to the scenery. The houses are round, with conical roofs, built mostly of mud, about 20 ft. or 24 ft. in diameter. Many of these round houses are built in the premises of each master or head of a family, and enclosed with platted grass or fences, which screen the whole group from the gaze of passers by. A narrow public street runs from one end of the town to the other, fenced in on both sides with grass, with now and then a lane or cross street. Except where the fences had been neglected, the inner yard of a group of huts was not visible from the street. Now and then the front of some premises is open to the street, and the people pass their time there in the heat of the day, under the shade of trees. If the town of Hamaruwa were regularly laid out, according to the plan of a civilised country, it would present a very delightful appearance; but at the time of our visit many houses had fallen in, and the sites were

overgrown with grass, others were planted with guinea corn, while a large portion were only partially fenced in and cultivated. The town, though situated on a hill, with a rocky substratum, is yet sandy, and thus dries immediately after the fall of the rain; and though situated at the foot of the Muri range, yet is not so near as to suffer any inconvenience from it. At night there was perfect silence in the town, no singing or drumming was heard, and the absence of light in the houses added to the dead stillness of the night. The inhabitants have no palm-oil, shea butter, nor nut oil for lights, and their sauce is made with cow butter. Cowries are not used, nor any other medium of circulation, but all is done by exchange, as in Zhibu. I had not time enough to inspect their market, but I think it must be very poor, and nothing like those held on the banks of the Kowara, and westward to the sea-coast. They procure water at the foot of the mountains, at a distance of nearly half-an-hour, and it is brought by the women in earthen pitchers, borne on the shoulder, because the mode of dressing their hair, plaited like a ridge, does not allow them to carry loads on their heads; many, however, who are not so circumstanced as to keep their hair always dressed in that manner, bear burdens on their head. Very few goats and sheep were seen in the town, and no fowls; perhaps, all these creatures are kept at their farms under the care of their slaves, but from the difficulty of purchasing any for the use of the ship, I think they can possess very few. The difficulty in getting horses to carry us from Hamaruwa to the river side, may, in like manner, be taken as a proof that they do not posses many, or else they did not wish to hire out their war horses for such a journey. Their slaves are chiefly employed in their plantations of Indian and guinea corn; but there is very little rice, although thousands of busbels of the latter might be cultivated to feed millions of people, the banks of the Binue being particularly adapted for the cultivation of this plant, after the fall of its mighty waters. The Filani themselves being military men, do not make agriculture their chief employment. They are very dirty in their apparel. It would seem that from the time tobes, shirts, trousers, and other garments are put on new, they are never wetted, except it be by rain, till they are worn to rags. With the majority, the tobes and shirts constitute their apparel by day, and their covering by night, and the trousers are often used as bags, in which corn or other things are carried. The females are cleaner in their apparel, and bestow more pains in plaiting their hair, and ornamenting it with flat pieces of brass, and lead, and copper rings, which are fastened on them in a fanciful manner. Large brass, lead, or iron ear-rings are suspended in their ears, and larger and ponderous rings of the same metals are worn round their arms, wrists, and legs, according to the means of the wearers; these metals, and some silver, come across from the desert to the Bornu and Hausa countries, whence they are purchased from Moorish merchants, and brought to this part of the country, the traders receiving in return slaves and ivory. Many of the rings are manufactured in Kano and Kasthina, in the Haussa country, and there are some Kano brass-workers even at Hamaruwa, who are carrying on their trade with much success; some specimens were bought from them. Traders from Kano and Katshina visit Hamaruwa in large caravans, and sometimes pass onward with other parties to Adamwa, where they purchase slaves and ivory, the former carrying the latter, and both are sold to the Moors in Kano or Bornu. In this way tons of ivory are yearly carried away from the banks of the Binue, and the country is depopulated by the slave-dealing Filanis, Sometimes the ivory and slaves find their way to the west of the Kowara, and thence to the coast. Two routes to Yolu from Hamarawa were given us by Ibrahim; the one of fourteen stages, of nearly a day's journey each, round the Fumbina mountains, circuitous but safe, being occupied by, or under the influence of the Filanis, and the other very short, of only four days' journey along the left side of the Binue but dangerous.

"Although this period, the latter part of September, was not, as we afterwards found, that of the highest rise of the river, a temporary fall alarmed us, and preparations for a return were made; but, in the meantime, the bodies of the party had gone up the river in a boat, and had reached a point called Dulti, about thirty miles above Tshomo, and about 420 miles from the confluence.

"One object of our expedition had been to inquire for the traveller Dr. Barth; and, though we heard of white men, we did not know that, three years previously, he had crossed the Binue at its junction with the Fáro, not more than seventy miles from the limit of our expedition. It is interesting to remember his description of the noble stream. He says:—'The principal river, the Bénuwé, flowed here from east to west, in a broad and majestic course, through an entirely open country, from which only here and there detached mountains started forth. The banks on our side rose to twenty-five, and in some places to thirty feet, while just opposite to my station, behind a pointed headland of sand, the Fâro rushed forth, appearing, from this point, not much inferior to the principal river, and coming in a fine sweep from the south-east. The river, where we crossed it, was at the very least, 800 yards broad, and in its channel generally eleven feet deep, and was liable to rise, under ordinary circumstances, at least 30, or even at times 50 feet higher. The second river, the Fáro, is stated to come from Mount Lábul, about seven days' march to the south. It was at present about 600 yards broad, but generally not exceeding two feet in depth, although almost all my informants had stated to me that the Fáro was the principal river. The current of the Fáro was extremely violent, far more so than that of the Bénuwé, approaching, in my estimation, a rate of about five miles, while I would rate the former at about three and a-half miles an hour; the current of the Fáro plainly indicating that the mountainous region whence it issued was at no great distance.'

"At this point we leave the River Bénuwé. What is its origin remains at present unknown, but we have sufficient data to guide us to some general conclusions. From its vast volume, its collecting area must be large. From its extraordinary and rapid rise and fall, that collecting area is probably a mountainous region, and from the comparatively slow current the fall for a very considerable distance above Tépe must be very gradual. The River Welle, discovered by the German traveller, Schweinfurth, would seem to answer to these conditions, although he assigns this to the system of the Shary, because no other region could supply the volume of water which that river pours into Lake Tsad. If this is so, the source of the Bénuwé must be sought still more to the south. Now, if the Welle becomes the Shary, which at Lake Tsad has almost exactly the volume and current of the Bénuwé at Tépe, it is not improbable, when we remember the rain-fall of this part of Central Africa, that the course of the Bénuwé is about the same length as that of the Shary and Welle. Then removing its sources sufficiently to the south to allow room for two collecting areas of equal magnitude, we are almost driven to place its sources about 3 south, and in longitude about 25 east, which is not more than 100 miles from Nyangué, on the River Lualaba. Is it possible that the unknown Lake Sankorra may find an outlet in the Bénuwé?

"It is somewhat remarkable that in the course of a journey of 700 miles, we come in contact with no less than 13 different languages. Ten of them are apparently of the same family, and bespeak aboriginal tribes. One, the Mitshi, is apparently aboriginal, but the language is entirely peculiar, while two are languages whose original homes are remote, they have reached the Niger and Binue, the one accompanying Mohammedan conquest, the other in the path of trade.

"The people we passed in our ascent of the river are

the Oru and Abo in the Delta, the Igara on the left of the Niger, the Kakanda at the confluence the Kowawa and Binue, the Bira, Bassa, Dona, Mitshi, and Djuku, otherwise called Apa, or Akpa, or Baibai, the Kororofa, and the Fula on the Binue.

"1. The Oru, or Ijo, or Udsr of Koelle are identical with Brass, at the mouth of the Nun, on the coast, otherwise called Itebu or Nempe, by their Ibo neighbours. This language is spoken to the extent of 100 miles from the mouth of the Nun, to the boundary of Abo territory, how far inland towards Benin, on the right, and towards the Ibo country, on the left of the Niger, is yet unknown.

"2. The Abo is a dialect of the Ibo language, commencing from about the Benin branch of the Niger, and extending to Asaba (Onia market of Trotter). It comprises a district of about 50 or 60 miles along the banks of the Niger, and is very extensively spoken in its various dialects in the countries inland, on the left bank of the Niger, as far as we could ascertain, from the information we collected, to Cross River, on the back of Old Calabar; the Calabar or Efik and Bonny trade with the Ibo in the interior—Isuama seems to be the leading or popular dialect of this language.

"3. The next country after the Ibo, on the banks of the Niger, is Igarra; the language of Igarra is the same as the Akpotto, and is spoken from Adamuga to the confluence of the Kowara and Tshadda, to the extent of 100 miles on the banks of the Niger. It is also extensively spoken inland on the left bank of the Niger, to the Mitshi country, on the left bank of the Binuo—about the longitude of Ojogo.

"4. The Kakanda is the next country on the banks of the Niger, and the language is a dialect of Yoruba. This people have been so much driven about, that the limits of their country are very difficult to ascertain; they inhabited the mountains on the right side of the Kowara and border on Nupe: at present they inhabit chiefly the left banks of the Niger, below the confluence, since they were expelled from their mountain holds, by Dasaba, King of Nupe.

"5. The next country after the Kakanda is Nupe, now governed by King Umoru, with whom we are on most friendly terms.

"6. From the confluence on the right side of the Binue, is the Igbira country, called Koto by the Haussa, and Kotokori by the Yoruba; since their country has been overrun by the Fulah, they have removed to the left side of the river, in the country of Akpotto. Their language is different from Igarra.

"7. The next country after Igbira, on the right side of the Binue, is Bassa, whose language appears to be a distant dialect of the Nupe. Their country has also been overrun by the Fulah, and they were obliged to seek refuge in Akpotto land, after tho example of their neighbours, the Igbira.

"8. The next country on the right side of the Binue, is Doma, also called Arago, a tribe of which is called Agatu, inhabiting Akpotto land on the left side of the Binue, to which they had been driven by the Fulah.

"9. The next country on the left side of the Binue, is the Mitshi, whose language is very little known and very peculiar to itself. The Mitshi country commences, as it appears, opposite Ojogo, and is mixed with the Akpotto and with Kororofa, from which it is difficult to distinguish the boundaries. They are chiefly independent, but somo portion of them pay tribute to Wukari, king of Kororofa.

"10. The next country after the Mitshi, is extensive,—Kororofa having Wukari for its capital, and the language spoken is Djuku, commonly called Akpa, but they call themselves Baibai. The language is spoken as far as Hamaruwa, now under the government of Mohamma, the Fulah Sultan of that country.

"11. The next language we met with on the Binue, is the Fulah.

"12. The most important of all the languages is the **Hausa, the commercial language of Central Africa.**

"With regard to the Hausa language, from the prefatory remarks to Schön's Hausa vocabulary we learn that the territory in which the Hausan is the vernacular language may, with some limitation, be said to be the Soudan. A glance at the map in Dr. Barth's most instructive "Travels" will show that the territory in which the Hausa is the vernacular language is of considerable extent, probably greater than that occupied by any other language in Central Africa. It is, moreover, not only in those parts that this language is known and understood, and serving as the medium of communication: it has, from various causes, such as the dispersion of Hausas among other nations, through the slave-trade, the commercial pursuits of the natives of the Soudan, and the beauty of the language itself, become, as it were, to Africa, what the French is to Europe. Sierra Leone contains many of every province of Hausa. At Cape Coast, Lander engaged his faithful Paskoe, the Hausa interpreter, with whom he commenced his travels at Badagry; and there is every reason to conclude that the Hausa language has been the only medium of communication and intercourse with people, chiefs, and kings, from Badagry to Borgou, Rabba, Boosa, Yaouri, Egga, and down the Niger to the Ibo country. No native words are found in Lander's three interesting volumes except such as are Hausa, and the author himself very frequently refers to the extent of the Hausa language. 'It is understood,' he says, 'by the generality of the natives of Borgou, both young and old, almost as well as their mother tongue, and it is spoken by the majority of them with considerable fluency.' At Gunga only it was that even the Hausa language was not understood."

Bishop Crowther corroborates the above statement from his own experience and observation in the River Niger as far as Eggan.

"Leaving the west, and passing to the north, it has thero also spread far and wide, and obtained the same notoriety as in the west, every traveller bearing testimony to this fact. Clapperton's incidental allusions to the importance of the Hausa language are numerous. Oberweg congratulates the expedition in having met with an interpreter who was master of Afnu, that is the Hausa language. Barth, writing to Professor Lepsius from Ai-Salah, speaks of the absolute necessity of mastering the Hausa language, and of his inability on that account to pay much attention to the Tuareg, observing that it was the less to be regretted, since all Asbenawas spoke the Hausa, and used it even more generally than the Targia.

"As to the countries along the Niger and Binue, it was found that from the confluence to Hamaruwa, a distance of 300 miles, the Hausa was understood, and of immense service to the expedition.

"At Oru, in the Delta, we already commenced meeting with solitary opportunities of communicating with the people through Hausa slaves. From Abo we engaged a Hausa interpreter, who was very serviceable to us throughout the expedition. At Idda we found that the Hausa language was becoming more generally spoken by the inhabitants; salutations in that language generally sounded in our ears. At Igbegbe, near the confluence, the Hausa is one of the prevailing languages spoken by the mixed population of that market town, and it is the chief medium of communication in commercial transactions, though Igbira is the language of the place.

"At Yimaha in the Igbira country, at Oruku in the Bassa country, at Doma, also among the hitherto unknown Mitshis, among the inhabitants of the extensive Kororofo, and with the Fulanis of Hamaruwa, the Hausa language was the chief medium of communication, both with the chiefs and with the people whom we visited during tho last expedition; and I was told that the knowledge of Hausa will bring any one to Mecca.

"**All the Mohammedans understand and speak the**

Hausa language, and through it the Koran is explained and interpreted in their own mosques throughout Yoruba; so that from Lagos, Badagry, and Porto Novo, and upwards to the Niger, where Mohammedans are found, the Hausa language is spoken by them.

"The other important language of this part of Africa, is the Fulah or Pulo, or Filani, a remarkable people who are found at Timbo and Falaba, on the west coast and have pushed their conquests as far as Yola, to the south of the Binue. Those of the natives who reside in the colony of Sierra Leone, call themselves Fula-men, and their language the Fulah language. The proper and indigenous name for the Fulahs, as we have called them, is Pulo, in plural Fulbe. Dr. Barth was told by the natives of the interior, of the existence, in bygone days, of an ancient kingdom of Ghanata, with a central town, Kazaka. The name of the nation must have been Azer. At a primative period of their history they were led to leave their paternal abodes to find a more congenial homestead in the plains that form the rich water-shed between the upper course and of the river Jaliba and the Maio Balleo, in the west. It would appear that their wanderings towards the west had taken place about the sixteenth centuary. We now find a strong Pulo empire in a north-westerly direction, from the upper course of the Jaliba, with a government town of Hamd-Allah. This court, with the numerous war men at its command, is called by the rulers and people of the principality of Futa Jallo and Toro, Hubube. But the larger stream of this inland emigration must have spread higher up; thus the extent of land, now occupied by the western Fulbe, between the young Niger on the one hand, and the Senegal on the other, is called by the territorial names of Futa Jullo and Futa Toro, with the seat of government at Timbo. These regions the emigrated Fulbe appear to have regarded as the landmarks to their western progress, and, although after their conversion to Islam, they conquered many more countries, in obedience to the dictates of their newly-embraced religion, they maintain their domiciles within these confines to the present day.

"In the course of time when, by the zeal of the ruling *walis*, the doctrine of the Prophet had become the national creed of Futa land, the Fulbe, in obedience to the dictates of Alquoran, and emboldened by the increase of numerical strength, agreed upon a holy war, for the coercion of their heathenish, and as yet unbelieving, neighbours and fellow-countrymen. An opportunity soon presented itself, at a heathenish feast and dance, when one of the Moslem priests tore up the drum of an unbeliever, and the offence thus given to the idolaters was received as an uncalled-for provocation. An endeavour on the part of the heathenish populace to resent the outrage committed on their hereditary practices, was eagerly seized upon by the fanatic Fulbe, who regarded this incident as the propitious moment for entering upon the Jihade, or holy war against the unbelievers. Thus a crusade began, which extended to the neighbouring tribes, when a number of nationalities, one after the other, were forced to accept the Crescent in exchange for their hereditary and traditional superstitions. The Fulbe, hitherto ruled by Alfas and priests, resolved then to choose a king, to take the supreme command of their armed hosts in their frequent warfare, because, after the Moslem tradition, the wars of the faithful with unbelievers, to the intent of their conversion, is unlawful without a king or supreme head. The royal dignity was then, by a plebiscitum, conferred upon the Alfa of Timbo, an official person who unites the office of magistrate with the authority of a high priest. From henceforth this dignitary assumed the two-fold authority of Imam and king, and possessed the prerogatives of watching over the interests of the faithful in spiritual matters, and of taking the leadership in their politics. The first attempt of the Fulbe to suppress heathenism became successful, and, with the introduction of the doctrine of the Prophet, also the political supremacy of the Futa dynasty over the surrounding territories, became established and finally acknowledged. Gradually the warlike spirit of this gifted nation led them to greater success among many contiguous nationalities; their influence is great, and their name respected on the banks of the Senegal, the Rio Pongas, the Nunez, the Scarcies; they influence the trade far into the interior, at Sego, Buria, Sangara, the so-called gold countries; their importance is felt among the Bambaras and Mandingoes; in the Sulieman, Limba, and Koranko countries, and has paved itself open roads and easy ways through the Susus to the Mellacoure, and they have obtained welcome passes through the Timane and Sherbro countries to the British settlement of Sierra Leone. As enterprising traders, they convey the gold-dust and ivory, obtained from the distant Serankules, to the French colonists of the Senegal and to the stores of the European and mercantile population of Freetown, in Sierra Leone. The Fulbe, in their further conquests, seem to have been satisfied with the establishment of their imported religion and the expulsion of heathenism, and then, after receiving guarantees for the acceptance of their Protectorate, to have withdrawn their numerous armies to the confines of their fertile homes of Futa Jallo and Toro.

"Anything like even a vague estimate as to the numerical strength of the Pulo nation we have at no time been able to obtain, since we never met with any African traveller far and long enough to undertake a reliable estimation. Suffice it to say that this interesting nation occupies a territory, both irregular and wide-spread, towards the interior; according to Dr. Barth, there is a considerable part of them in Adamawa; they are in power at Sokoto; and there is ample proof of their being largely mixed with the Hausa nation.

"Even since the times of Denham and Clapperton, the warlike Fulahs or Filani have continued their hostile and predatory attacks on the more peaceful tribes; towns are still destroyed, and it is their frequent attacks which unsettle the tribes, and render them suspicious of the presence of strangers."

Such are the countries, with their characteristics, which border on the River Niger so far as it is actually accessible for purposes of trade. It is almost impossible for an outsider to obtain any information as to the present trade on the river. I believe that eight steamers are now employed, and I venture to think that were no further advance to be made, the products for export and the markets for English manufactures which the 300 or 400 miles of that river now used contain, seem to hold out hopes of extending that trade to almost any amount.

This brings me to speak of the future which seems to lie before us in connection with this grand highway into Africa.

By the two branches of the river access may be had to the following important States:—The kingdom of Sokoto, a Fulah State, lies in the fork of the confluence of the two rivers; it has an area equal to that of the British Isles and borders eastward on the Negro kingdom of Bornu. Adjoining Sokoto on the west, and lying on both banks of the Joliba is the kingdom of Gando, made of loosely confederated Hausa States.

Still further to the north-west, and bordering on the river, lie the Sonhray negroes, the descendants of a once powerful people, now numbering, according to Barth, about two millions. Their ancient capital, Gao, for six centuries the most important in all negroland, was, when seen by Barth, a village of about 400 huts in the midst of overgrown ruins.

Still further to the north-west stands the im-

portant town of Timbuktu, with a population of 1,300, and a famous emporium for traffic carried on between the north and the Negro States of Central Africa. Like one of the free cities of Germany, it owns no master, and stands much by itself. We then come to the State of Massina, with its capital city Hamda Allahi. It must, however, be remembered, that the rapids at Boussa present a serious obstacle to the navigation of the Kuorra, while the hostility of the Mahommedan populations of these various kingdoms may be another difficulty in the way of any advance in this direction.

The Binue branch of the river seems, however, to offer access to a very large and important part of the continent. In addition to the countries lying to the north and south of the river as far as Dulti, the Binue would give access both to semi-civilised Negro States further in the interior, as well as to virgin and untouched countries, such as Adamawa.

From Keith Johnston's admirable compendium I take the following:—

"This region, situated between the Fulah States on the west and the so-called "Egyptian Sudan" on the east, is occupied by the negro kingdoms of Bornu, Baghirmi, and Wadaï. Bornu, the neighbouring State to Sokoto, is properly conterminous with the basin of Lake Chad, that great lake of Central Africa, for somewhat more accurate information concerning which we are chiefly indebted to the most recent explorers, Rohlfs and Nachtigal.

"Bornu is a lovely and fruitful kingdom, considerably larger in extent than England, decked in all the splendour of the tropical world; but also subject to all its inconveniences. It is inhabited chiefly by the Kanuri race, which has a language of its own, but is otherwise mixed with a great deal of slave and foreign blood. Like all the other States in Central and Egyptian Sudan, Bornu has adopted Mohammedanism, though many heathen lands stretch southwards from it, about which we are still almost in complete ignorance.

"Kanem, an undulating but generally sandy country lying on the north-east side of the Chad, is partly dependent upon Bornu. Only that portion of it which lies close to Lake Chad is well-peopled by the Kanembu, the original owners of the soil, allied to the Tebu, who are scattered over the northern regions of Kanem; but mixed up with the Kanembu are numbers of immigrant Arabs, and other foreign peoples.

"The natives of Baghirmi are distinguished by their handsome appearance, warlike spirit, and industrious habits, but are otherwise bloodthirsty and cruel.

"North-east of Baghirmi lies the sultanate of Wadaï, the northern parts of which are watered by the periodically flowing stream of the Batha. Till quite recently Europeans have been barred all access to this country. The brave Edward Vogel paid with his life his daring attempt to penetrate into Wadaï, and Dr. Nachtigal, to whom geography is so deeply indebted for his discoveries in Central Africa, was the first to succeed in crossing the country to Darfur on its eastern border, and collect reliable information on this region.

"Both Bornu and Baghirmi present a surprising picture of a remarkable state of Negro civilisation. This culture may in many respects seem somewhat eccentric and even barbaric; still it cannot be denied that we here meet with entirely independent attempts at the formation of original States and social policy. Amongst these nations we find a fully organised administration, a court and government with all its accompanying dignities and offices, a military system, which for Central Africa may be considered fairly well worked out; in a word, a people of industrious habits, tillers of the land, and skilled in many of the arts of life—a people that can in no sense be regarded as "savage," although still addicted to many practices looked on by us as barbarous. Thus the whole policy of the State is based on slavery, and the slave-trade, especially towards the north across the desert in the direction of Fezzan and Tripoli, still flourishes vigorously throughout the whole of the Mohammedan States of Sudan.

"The capital of Bornu, Kuka, or Kukawa, situated close to the western shore of the Chad, is one of the greatest markets of all Central Africa, second only, perhaps, to that of Kano, and morning and evening its streets are so crowded with cattle, camels, sheep, and poultry, as scarcely to leave room for the bustling population. Over the whole western division of the town, and in the open space between it and the Government residences, booths are thickly scattered, and in these butter, milk, eggs, corn, fruits, and all kinds of wares, are exposed for sale. Immediately outside the gates a horse-auction is held. Here one may buy a first-rate riding-horse for 20 dollars, and the horses of Bornu are famed throughout all Negroland. Rohlfs notices that if Bornu were in direct communication with Europe, or united to the Mediterranean by some more rapid means that of the camel caravans, which require four months to cross the desert, the greatest advantages would result to both countries. Or why, he asks, have not the English, Germans, or French, who are most interested in supplying Africa with wares, opened out the much shorter route to Bornu by the Binu River? Horses, cattle, asses, sheep, goats, ivory, ostrich feathers, indigo, wheat, leather, dried fish, skins of lions and leopards, and many other national products, are here in vast quantity, and comparatively valueless; while Bornu requires all sorts of European manufactures, such as cloth, paper, knives and razors, guns and powder, spices and sugar. Tea and coffee, however, would be useless here, for the kola nut, which the Kuka people chew continually, takes their place.

"The Sonrhay, like the other pagan tribes south of Baghirmi, are industrious tillers of the soil, raising crops chiefly of durra and millet, which they barter for tobbaco, pearls, and cowry shells. Their houses are made of straw, except the granaries, which are of mud, cone-shaped, and with a single opening at the point above. Besides horses, they keep goats, sheep, and dogs, the last being highly esteemed as an article of food. Horned cattle are rare."

The State of Wadai has been passed through by Dr. Nachtigal, who remarks upon the poverty of the land, and the rough hostility of the natives. Their principal articles of export are slaves, ivory, and ostrich feathers. From this State the stream of traffic seems to turn north and south, both reaching Egypt through Wanganga, in the Sahara, and Darfur, and considering the advent of Egyptian power in Darpu, it is probable that any development will come from that direction.

Nearly 40 years have elapsed since the Niger Expedition of 1841, and it is a considerable time since the withdrawal of an English vice-consul from the Upper River, but still English influence has advanced, and is advancing. It is the opinion of one well versed in all that concerns the Niger, that so good is feeling towards the English among the rulers of the States I have mentioned, to the north of the Binue, that there is every opportunity for the introduction, to a large extent, of British commerce. Bishop Crowther adds that further attempts, carefully planned and entrusted to men who would conciliate and not alarm the natives, would carry geographical discovery and commercial enterprise far to the interior.

It must also be remembered that another most important accessory to successful enter-

prise to be found in the important linguistic labours of two of the missionaries of the Church Missionary Society, Messrs. Schon and Reichardt, who have succeeded in reducing the two great languages, and have already mentioned the Hanssa, and the Fulah, the Greek and Latin of the Niger basin. I would remark in passing that such labours are sure to bear fruit some day. Witness the result which has attended those in Suaheli of Krapf and Rebmann. The mission party, who reached the Mtesa King of Uganda last June, found that Suaheli was spoken by the king and many of his court, and as soon as he and they are taught to read, portions of the Bible and other books are ready for their use. In the meantime for the trader and explorer here are the vocabularies and grammars of the Fulah and Haussa languages ready to hand.

But notwithstanding all these fair opportunities, there is one most serious, nay, fatal obstacle which stands in the way of such an advance as shall lead to their full utilisation.

It is my belief that if we were to ask the African merchants, now trading in the river, their view of the present state and prospects of trade, we should be told on all hands that it was being conducted at a loss, and that future prospects were very bad. Now, although such an answer may be due to the traditional policy of the African merchant, who has always, in order to keep the trade in a few hands, depreciated or been entirely silent as to its prospects, it is manifest that to the man who looks a little beyond mere mercantile returns the present prospect is not inviting.

With all its capabilities and openings the Niger will never be a great artery for commerce unless an effort is made to systematise the present ill-regulated and selfish system of trading ventures.

I have alluded to this subject in my previous papers on Eastern Africa. I hold that the experience of the past teaches us that mere exchange and barter is not in itself an unmixed good; on the contrary, unless limited and controlled, it is productive of evil to both sides. When uncontrolled and unchecked, it is apt to degrade instead of benefiting; for, when advantage is taken to pass off inferior articles, or to pander to debasing vices, neither side can escape moral injury. I have often noticed with regret that to make a negro drunk is thought rather a good joke, and I am ashamed to think of the character of the traffic in rum and ardent spirits which passes into poor Africa.

Capt. Cameron, speaking in this room, laid down a proposition in which I am sure we should all concur, viz., that missionaries to Africa should be gentlemen in all their actions. I would say that the standard for the trader should be as high, if we wish to secure such a position and control as befits enterprise under the English name.

Again, traffic uncontrolled and unregulated by a proper knowledge of the wants of the market, and the amount of supplies about to be poured in, must result in loss, especially where the fashion varies in some of the chief articles of import, and where the only apparent object in view is a frantic eagerness to outstrip all competitors, and drive them from the field.

Subsidiary difficulties and hindrances there also are, such as the remarkable rise and fall of the river, which in the vicinity of the confluence is as much as from 30 to 40 feet; and while during the floods there is depth of water for almost any craft. in the dry season, none but vessels of very light draught could pass up and down the river. Nearly all the trading steamers are compelled, owing to their deep draught, to make their upward journey as the river rises in June, and turn seawards the moment it begins to fall, which is generally in the first week of October.

The short time, therefore, during which trade can be carried on at the upper stations, places the European merchant at great disadvantage. It embitters, so to speak, the fierce competition between the merchants, and enhances the risk which the white man runs from the climate. This special risk, therefore, is another obstacle to advance here, as it is elsewhere in tropical Africa.

Here, too, as elsewhere, the jealousy and suspicion which characterise the native tribes, is a serious hindrance to advance. On the Delta it is jealousy, fostered by those whose interest it is to keep the trade as much as possible in their hands; while on the upper rivers it may be only suspicion, resulting from the slave hunting and filibustering expeditions of the Fulah's.

It may be asked, are these obstacles, great though they may appear to be, so insurmountable as to render all advance hopeless? Is this great and important highway to Western Central Africa to remain as at present?

Can no effort be set on foot to open up, in an adequate way, these vast regions to the commerce and manufactures of England? Surely, a trade which in 30 years has grown to nearly two millions per annum, to judge by the returns of the Board of Trade, gives promise of development to almost any extent.

I would, in conclusion, endeavour to answer these questions, and offer some remarks on the measures which would make the future of the Niger all we could wish it to be.

If we contemplate the opening up of Western Central Africa by means of this great highway, English capital and energy must enter upon the undertaking in the spirit, and, as far as practicable, upon the lines of the old East Indian Company.

Union is strength. Let the future be kept in view in all present action, and let there be that combination of purpose and plan which shall call into play, for the benefit of Africa, all those qualities which have made English rule and English enterprise so beneficial in our Indian Empire.

I am glad to think that similar suggestions, with regard to the development of Eastern Central Africa, have borne fruit, and, ere long, we may hear of a movement which may produce for that land the results this Society desires to bring about.

Should such combined effort be set on foot for Western Central Africa, I would suggest, as practical measures, the arrangement of uniform rates for trade, rules for the conduct of business, avoidance of the fatal system of credits to native traders, careful agreements with all native tribes and chiefs, the abandonment of the present wholesale dealing in liquor, and the constant presence in the river of one or more suitable steamers, under proper officers, to act as patrols and inspecting chiefs.

Let the river traffic proper be carried on in vessels adapted to all seasons, whether flood or dry,

and so economically built as not to require the heavy capital outlay which must largely dilute the profits on the goods carried. At present, the steamers employed are built in this country, and the last constructed, the *Edgar*, makes the voyage from Liverpool to Lokoja. Thus, the ocean passage compels a size and construction utterly unsuited to river navigation, and an expense both for hull and engines far beyond the needs of the trade.

A lesson might be taken from the river craft used in America. Simple in construction, light and strong, almost flat bottomed, and of great carrying capacity; the engines rude, some parts even of wood, yet up to the work, the vessel attains great speed, and is able almost to go anywhere, or, as put by the Yankee skipper, "to do ten knots an hour over a grass field after a heavy dew." With two classes of vessels employed, the trade could always be carried on.

A distinction of course must be drawn between the ordinary oil trade in the Delta and the development of commerce on the upper rivers. Nothing, I conceive, could alter the main features of trade in the Delta, the character of the natives, the innumerable channels of the river, and the deadly climate, are almost insurmountable obstacles to the introduction of any system of control. The oil trade will probably continue to be carried on, as it is now, for all time, save with the alleviation to the lot of the white man, on which I will presently touch. Provision should also be made in the vicinity of the river for properly repairing and docking the steamers used in the river trade.

This might be done in connection with that which appears to me to be one of the grant wants of the Niger. The formation of central stations or depôts, where the agents of the various trading houses might permanently reside; where proper building yards and docks might be erected—in short a trading emporium—with all modern appliances. One such, and the chief depôt, might well be formed at Victoria, the new settlement at the base of the Cameroon Mountains, in Ambas Bay and while affording all the advantages of a trading depot, with docks and stores, the healthy slopes of the mountain rising to an elevation of 14,000 feet, would offer innumerable sites for such sanatoria as are eagerly resorted to by our English brethren in India.

Think of the white merchant shut up in his dismal hulk, say at Bonny, breathing a polluted atmosphere, and floating in liquid miasma, *ex uno disce omnes*; no wonder that the term of servitude frequently ends in the white man's burial ground at Rough corner, and that the motto, "a short life and a merry one," is very generally accepted and illustrated in a way which does not commend the Englishman to those around. In contrast to this, let us picture him leaving for a holiday, at reasonable intervals, to be spent in the life-giving highlands of these beautiful mountains. The term of service would be easily extended, and men who have all the hearts and sympathies of Englishmen, would have other thoughts than merely how to pass away as rapidly as possible their term of servitude.

Another such station might be formed on Kipo Hill, opposite Eggan. English officials, a consul at Victoria, and a vice-consul at Kipo, would do much towards maintaining English prestige, and so securing an adequate return for English outlay. It is true that a vice-consul had to be stationed at Lokoja, but owing to the peculiar character of the trading season, it was found that he was not wanted for a considerable part of the year, and the monotony was so irksome that when poor Fill was killed, the appointment was not filled up. But the testimony of Mr. Johnson to the comparative salubrity of Kipo, leads me to hope it may ultimately be chosen for a European settlement. At both these stations, and attached to the patrolling steamer, should be properly qualified medical men.

Finally, let me say that I regard the ultimate prospect hopefully. I cannot forget the powerful influence of Christianity, and I rejoice in knowing that means are being employed for the steady advance of its mild and beneficent sway. I rejoice in knowing that European trader and native chief alike bear testimony to the gentleness discretion, zeal, and tact, which characterise our native Bishop, Samuel Crowther; and in the new means which have been placed at his disposal for the steady progress and development of his mission work, I recognise one of the most powerful accessories to such an advance into these regions as shall promote, not only our own commerce but the highest and best interests of the inhabitants.

DISCUSSION.

A Member asked Mr. Hutchinson, with reference to the projected waterway communication to the north, whether there was a probability of anything being done with regard to effecting a connection between the Niger and the North of Africa across the Sahara.

Mr. Hutchinson said that an association had been got up some time ago to penetrate from the coast line, somewhere about the parallel of Canary Islands, to the interior, by means of flooding the portion of the Sahara supposed to be below the sea level, and so carrying a canal across to Timbuctu. He had referred to the scheme in the paper, but confessed it had not greatly impressed him, thinking there was not sufficient evidence to show what was the real level of the Sahara at the point spoken of. The uncertainty of the enterprise had prevented his giving any great attention to it, and he was not at all posted up in the subject. It might, however, with regard to another part of the paper, be interesting to know what means had been placed at Bishop Crowther's disposal for carrying on his work. A steamer had been specially constructed for navigating the upper waters of the Niger, and carrying on the work of civilisation there at all times. The Bishop had penetrated 400 miles above the confluence of the rivers, one of which, the Binué, was as broad and large as the Shary, flowing into Lake Tschad, so that, on theory, a course of 1,200 miles might be given to it from that point. The Bishop had been kindly received in the country, and the English name was well received there. How far the good influence of Bishop Crowther had extended it was impossible to say, but there could be no doubt that, in that direction, it was great, and there was every reason to hope that the time had come when the quiet and steady advance of missionary enterprise, the appointment of teachers, the institution of schools, and the formation of acquaintanceship and friendly relations with the chiefs all along the river, would lead to its opening up, to a very great extent. The Bishop's personal knowledge of the stream

could be gathered from the fact that he had piloted the vessels under the command of Admiral Sir Wm. Hewitt, when he was despatched to punish the natives for some offences. More especially, since the Ashanti campaign, had the prospect of a steady advance on the part of Englishmen in that region appeared hopeful; and it had, therefore, been considered that the time had come for placing facilities at Bishop Crowther's disposal. The steamer spoken of was now on its way out. She was a small paddle-wheel vessel, admirably constructed, and drawing only 3 ft. 9 in. of water, and was intended to be used at first in carrying on missionary work on the river; then, in the first available dry season (probably next autumn), she would attempt the ascent of the stream. A well-known gentleman, Mr. Buxton, who was on the point of going out to Africa as a naturalist, had proposed to accompany the vessel if permission could be given. The Church Missionary Society had, besides, offered to render to the Geographical Society any facilities they could for the exploration of the river; and for the interests of England it was most important that that offer should be accepted as soon as possible, as an expedition was being projected by the French Society of Marseilles to attempt the exploration of the Binué River, and to reach it from the Congo. It would be a pity that such a work should be wrested from English enterprise; but it seemed the Geographical Society were so occupied in other schemes that they would not look at the Church Missionary Society's proposal. The French, who knew what they were about, were gradually coming down, and it might well be to their interest to work their scheme so as to get behind the English in these countries of the Gaboon, when they would practically surround us on the West Coast of Africa. They were actually in treaty with the King of Dahomey for the cession of a tract of country. One of our greatest difficulties—the controlling of the trade—would be added if the French got a hold in the country. The Sahara proposal made to the Geographical Society had not been accepted; but it would be well for the English still to get in advance of the French expedition, which had, indeed, already started under the command of a lieutenant who had distinguished himself in Algiers, and was accompanied by old French soldiers who knew how to control the natives.

The Chairman asked what was the exact knowledge possessed of the Welle.

Dr. Mann remarked that the Welle of Schweinfurth, after Capt. Cameron's return, was spoken of as being probably connected with the Congo.

Mr. Hutchinson said if the Welle was really the Shary, then it was unquestionably a river about 1,200 miles in length; and as the Binué was found to be of the same volume and breadth at Tepe, it must reasonably be assumed to be of about the same length.

Col. Grant said the fact was not yet known, but Stanley believed that the Welle would be found to join the Congo.

Dr. Mann said it would be rather premature to discuss as to where this river really went.

Col. Grant said the problem to be solved was an interesting one, but probably the Geographical Society wished to keep at present to their particular work on the Eastern half of the Continent.

Dr. Mann pointed out that there was an interesting point in the exploration of the River Binué not to be lost sight of—that of its running in a precisely parallel course with the Congo. There was a large tract of country between, and no doubt in that region lay part of the great mountain backbone of Africa, of which, probably, the Cameroons referred to in the paper formed one end. Great watersheds existed on each side of the great centre chain which ran first east, and then south, and possibly had a connexion with the great mountain range which ran down to Cape Colony. In reference to what had been done in making an examination of the depressed parts of the Sahara, the whole project had been based entirely on imagination, for there were no facts and no measurements to support it. It was merely known that there was depressed land there, and it was assumed that it would be possible to let in the sea, so that vessels might be brought through a gap cut in the coast, on towards Timbuctu; but the scheme had simply ended in two or three passages of a small sailing vessel between the Canary Islands and the point on the Coast aimed at, and all the money having been spent in making those voyages, nothing more was heard of the project. There was a great deal of work to be done on the Niger, and in the direction in which Bishop Crowther's work had lain. It was, therefore, to be hoped Mr. Hutchinson would have some substantial reason for further communications on the subject, in future times, respecting progress, and as new reasons arose for pressing on the work of opening up Central Africa by these great water routes, the existence of which were no longer problematical. The old notion that they were simply impassible fever ways had been completely set aside by Stanley, who had passed through in safety, bringing with him the greater number of his followers; and, with better laid plans, a great deal more might yet be done. Mr. Hutchinson had brought the subject forward at the express request of the African Section, who were anxious that it should be kept before the public. However large the meetings themselves might be, the *Journal* of the Society was, after all, the great agent of publicity, as for every person who attended to hear the papers hundreds read what had taken place. The importance and value of such communications as this paper could scarcely be over-rated. Every meeting bore fruit, and the Society's *Journal* was steadily becoming, in matters of this kind, a valuable book of reference, recognised as containing reliable sources of information, and finding its place on the shelves of most libraries.

Mr. Hutchinson then explained to the meeting the uses and place of manufacture of an interesting collection of objects of Central African trade, many of which appeared to be of Houssa, and not, as commonly supposed, of Moorish manufacture.

TWENTY-FIRST ORDINARY MEETING.

Wednesday, May 15th, 1878; Lieut.-Colonel Sir E. Du Cane, R.E., K.C.B., in the chair.

The following candidates were proposed for election as members of the Society.

Barrow, Benjamin, J.P., F.R.C.S. (Mayor of Ryde), Southlands, Ryde, Isle of Wight.
Bartleet, Major-General Henley Thomas, 2, Louisa-terrace, Exmouth, Devon.
Gover, Henry Charles, 86, South-hill-park, Hampstead, N.W.
Hargreaves, William, Moss-bank, Halliwell, Bolton.
Sakurai, G., 86, Albert-street, Regent's-park, N.W.
Sutherland, Gilbert D., M.A., Ph.D., Commercial Schools, Warrington.

The following candidates were balloted for and duly elected members of the Society:—

Banks, Edwin H., Highmoor-house, Wigton.
Gover, Dr. Milbank-prison, Westminster, S.W., and 49, Grosvenor-road, Pimlico, S.W.
Hadfield, Robert, Newhall-road, Attercliffe, Sheffield.
Hassard, Richard, 1, Westminster-chambers, Victoria-street, S.W.
Henderson, William, J.P., Devanha-house, Aberdeen.

Michie, Alexander, 55, Leadenhall-street, E.C.
Miller, Captain David, R.N., United Service Club, Pall-mall, S.W.
Rayner, J., Town Clerk's Office, Dale-street, Liverpool.
Reynolds, Vincent John, Canon's-grove, Taunton.
Riego, Miguel del, 284, Regent-street, W.
Wragg, Robert Thomas, 7, Great St. Helen's, E.C.

The paper read was—

DIETARIES, IN THEIR PHYSIOLOGICAL, PRACTICAL, AND ECONOMIC ASPECTS.

By R. M. Gover, M.R.C.P., Lond.

1. A study of dietaries in their physiological aspects is, in point of fact, a study of food in general; and a brief review of the uses and nature of food, will, I think, assist in the discussion of the practical questions which I desire to submit for your consideration.

Food may be generally defined as a substance which, when introduced into the body, renews some structure, or maintains some vital process. It consists, on the one hand, of organic matters containing a certain amount of latent or potential energy, which may ultimately become converted into dynamic or actual energy; and, on the other hand, of inorganic materials which, though not themselves capable of metamorphosis, play an essential part in building up the frame, and in preparing and maintaining the conditions necessary for those chemical changes and interchanges which are incessantly in progress in the animal economy.

I need not go far in search of a more particular and categorical definition of food, and no experiments are necessary in order to ascertain the elements of which it should be composed, for there are two sources of knowledge always at hand, namely, the composition of the body itself, and the ingredients of the aliment provided by nature for building up the frame of the infant.

The human body is found invariably to contain certain substances which may be deemed essential; but there is nothing in nature which is pure, "neither the invisible air nor the transparent water," and traces of other substances, which may be described as accidental, are not unfrequently found on analysis.*

The following is a list of the elements invariably found in the human body, with the quantity of each (according to Mr. Church's calculation) entering into the composition of a man in health, 25 to 30 years of age, and weighing 11 stone, or 154 pounds:—

Elements of the Human Body (Church.)

	lbs.	oz.	grs
Oxygen	109	2	335
Carbon	18	11	150
Hydrogen	14	3	150
Nitrogen	4	14	0
Phosphorus	1	12	25
Sulphur	0	8	0
Chlorine	0	4	150
Fluorine	0	3	300
Silicon	0	0	14
Calcium	3	13	190
Potassium	0	3	340
Sodium	0	3	217
Magnesium	0	2	250
Iron	0	0	65
	154	0	0

* See "Blyth's "Dictionary of Hygiene."

Milk has been well and concisely described by Dr. Guy as "an emulsion consisting of a certain quantity of solid elements, intimately mixed up with about eight times their weight of water." The "solid portion consists of less than half its bulk of saccharine matter, more than one-third of its bulk of the matter of cheese, somewhat more than a quarter of its bulk of oil or butter, with about one hundredth part of mineral substances, of which by far the larger proportion consists of phosphate of lime."* Milk may be said to be a model food, and no other food has yet been found so well adopted to the requirements of the young.

Having pointed to the composition of the human body, and to that of milk as the sources which at once enable us to recognise what are the necessary components of food, I proceed to state in a few words the work which it has to perform, and the mode in which force is liberated. In doing this I will resort to the analogy, now a familiar one, which may be traced between the animal system and a locomotive engine. In the case of the engine there is a material structure to be maintained; fuel is provided in the shape of coal and coke; the oxygen of the air enables the fuel to burn; water is converted into vapour; gases are generated; and, lastly, the incombustible material forms the waste ashes and cinders. The human body also presents a material structure; fuel is supplied in the form of food; the oxygen of the air combines with the combustible part of the fuel; water and carbonic acid are generated, and imperfectly oxidised or incombustible material is thrown out as waste. There is, therefore, in these two cases a close resemblance in the following points:—The oxygen of the air unites with that part of the fuel which is combustible, and in so doing sets free potential energy in the form of heat and motion. In the engine the heat produced is partly dissipated, and is partly employed in the performance of work. In the human body the forms of combination are less rapid and direct, but the ultimate result is the same. The conversion of the carbon and hydrogen of the food into carbonic acid and water, takes place in the muscles, glands, and every part of the organism to which oxygen finds access. The energy of some at least of the food may be said to be stored up in the body, of which it has become a part during the processes of digestion and assimilation. It will be seen from the foregoing, that although there are important analogies between the animal system and a steam-engine as to the liberation of force, yet that there are differences with regard to the mode of combustion in the two cases. In the latter case, oxidation goes on quickly; in the former, slowly, and in the midst of moisture. Moreover, the oxidation which goes on within the body to some extent consumes the body itself, so that a renewal of the structures of which it is composed is constantly necessary.

According to Helmholtz, the animal economy turns fuel to better account than the steam-engine; for while in the best engine only one-tenth of the force liberated by the combustion of fuel is realisable as mechanical work, the human body is capable of turning one-fifth of the power of its fuel into the equivalent of work. But it is

*See paper by Dr. Guy on "Sufficient and Insufficient Dietaries," Journal of the Statistical Society, vol. xxvi., page 241.

to be remembered, *per contra*, that the fuel of an engine is less expensive than that of an animal being, and it results from this, that human labour can never compete with consideration in economy with steam.

The classification of foods which I have found most convenient is that of Mr. Church, which takes into account both the chemical composition of these compounds, and the purpose which they serve in the body. Mr. Church divides foods into two great classes, viz., nutrients, and food adjuncts. Nutrients consist of incombustible compounds and combustible compounds. The incombustible compounds are composed of water and mineral matters, as common salt, and phosphate of lime. The combustible compounds consist of compounds of carbon, as starch, sugar, and fat, and compounds of nitrogen, as fibrin, albumen, and casein. Food adjuncts are classified as follows:—Alcohol, volatile and essential oils, acids, and alkaloids, as caffein in coffee and tea, and theobromin in cocoa.

I do not purpose, nor would time permit me, to trouble the Society with a detailed account of the functions performed in the animal economy by these several groups of compounds, and I will content myself with such a general sketch as can be comprised within a few sentences.

To begin, then, with water. This compound not only performs the important office of carrier to and from the ultimate structures, but it forms itself an essential part of every structure in the body. Without water no molecular change could take place, and any manifestation of life would be impossible. It may be truly said that wherever there is active life there is water.

Mineral matters are largely concerned in the construction of the animal frame, and they are essential constituents of the secretions. They aid in the transference of oxidised materials to the various tissues, and in effecting those subtle changes in which perfect nutrition consists. The most important mineral or saline nutrients are common salt, potash and soda salts, salts of lime and magnesia, and iron. Lime, in the form of phosphate, is present in every tissue; and, as Dr. Pavy remarks, "its incorporation with the nitrogenous constituent principles is so intimate, that much difficulty is experienced in effecting a complete separation without involving the destruction of the compound."* The relation of the organic and mineral principles to each other is so close as to render it possible that the union between them is that of actual chemical combination. It is important to remark that the various salts or mineral nutrients are not mutually replaceable; their distribution is not indiscriminate, but is determinate and fixed. Just as vegetables select from the soil in which they are growing the particular aliment which in each case is essential to their growth and development, whether it be lime, or potash, or silica, so do the individual tissues or fluids of the animal organism select and appropriate those salts which enable them to discharge their specific offices, the due performance of which is necessary to ensure normal development and vigorous life. Thus potash appears to be the alkaline salt for the blood cells and muscular fibre, while "the soda salts are more largely contained in the intercellular fluids which bathe or encircle the tissues."

* "Treatise on Food." Page 137.

The great importance of the mineral constituents of food is not sufficiently understood in the kitchen; and those who are helpless, as school-children, soldiers in barracks, lunatics in asylums, the poor in workhouses, and (may I not add) the rich in their mansions, are frequently deprived, through the ignorance of cooks, of those inorganic constituents which are as necessary to life as nitrogen itself. By way of illustration I will take boiled beef or mutton, which are common articles of diet, both in public institutions and private houses. In the preparation of this dish the object of the cook too frequently appears to be to abstract as large a proportion of the saline constituents as possible instead of retaining them in the joint; but even where skill is not wanting, a portion of the nutritive salts will escape into the liquor in which the meat is cooked, and this liquor or broth is too frequently thrown away, or does not bear a proper proportion to the ration or portion of meat served out. I will say nothing here of the injury done by salting, and the employment of too high a temperature in cooking; for to do so would lead me into questions of chemistry into which it would be out of place now to enter. I will therefore content myself for the present with stating that the various destructive processes to which a piece of boiled beef is subjected before it reaches the table, usually convert it into a mass of but little nutritive value.

The important part played by mineral matters in the animal economy is per haps most strikingly shown by the fact that the state of mal-nutrition which, in its highest degree, we call scurvy, appears to follow inevitably* on the absence of the lactates, citrates, tartrates, and other salts which form carbonates in the system.† Dr. Guy has shown, in the valuable paper to which I have before referred, that the omission of these principles has been the true cause of outbreaks of disease which have been wrongly attributed to a mere reduction in the quantity of food.‡ And, short of the production of scurvy, there are other forms of mal-nutrition manifested by the pallidity, decaying teeth, foul breath, and arrested development common among town populations, and probably due in a great measure to the partial absence of principles supplied by succulent vegetables in a fresh condition.

The poet, with a curious insight into physiology, has said:—

* "Practical Hygiene," by Dr. Parks, Fourth Edition, page 177.

† The following table shows the relative importance of the saline and other constituents of the blood:—

Water...	784·
Albumen	70·
Fibrine	2·2
Red corpuscles (dried)	131·
Fatty matters	1·3
Inorganic salts—	
Chloride of sodium	3·6
Chloride of potassium	0·36
Tribasic phosphate of soda	0·2
Carbonate of soda	0·84
Sulphate of soda	0·28
Phosphates of lime and magnsia	0·25
Oxide and phosphate of iron	0·5
Extractive matters, &c.	5·47
	1,000·

‡ For important information on the subject of scurvy in its various degrees, I would refer to Dr. Buzzard's excellent article in "Reynolds's System of Medicine."

"Herbs gladly heal our flesh, because that they
Find their acquaintance there."

as though he knew of the kinship shown by ready union and assimilation. The total quantity of salts in the blood, as shown in the table, amounts to between seven and eight parts per 1,000, and about half this quantity consists of common salt. The purposes served by some of the mineral matters are very evident. For example, bone acquires its solidity chiefly from lime in union with phosphoric acid. Analysis of dried bone shows that it contains from 66 to 70 per cent. of mineral matter, of which about 57 parts are composed of phosphate of lime, eight parts of carbonate of lime, one of fluoride of calcium, and one of phosphate of magnesia. The alkalinity of the blood enables it to hold albumen in solution, and the more readily to absorb digested food—hence the importance of the alkaline salts, which also assist in the removal and combustion of materials which have been used up and worn out. A scanty supply of vegetables, and of the saline matters which they convey, may not, perhaps, produce actual disease as an immediate and very obvious consequence, and yet, by undermining the general health, the approach of the enemy may be rendered fatally easy, and his final victory certain. I agree, in the main, with some remarks that were written more than forty years ago by an authority on the art of dining. "One of the greatest luxuries, to my mind," he says, "in dining, is to be able to command plenty of good vegetables, well served up. But this is a luxury vainly hoped for at set parties. The vegetables are made to figure in a very secondary way, except, indeed, whilst they are considered as great delicacies, which is generally before they are at their best, and then, like other delicacies, they are introduced after the appetite has been satisfied. . . . Excellent potatoes, smoking hot . . . would confer merit on any dinner; but they are as rare on state occasions as if they were of the cost of pearls. Everybody of genuine taste is delighted with a display of vegetables of a superior order; and if great attention were bestowed upon that part of dinners, instead of upon the many other dishes, dinners would be at once more wholesome and more satisfactory to the palate, and often less expensive. I have observed, that whenever the vegetables are distinguished for their excellence, the dinner is always particularly enjoyed; and if they were served . . . fresh from the dressing, it would be a great improvement on the present style." So wrote Thomas Walker in the "Original," a work which is, indeed, a "rich mine of profound wisdom." Changes have, no doubt, taken place since his day in the modes of preparing and serving up dinners, yet some of his remarks are only too true.

I will conclude what I have to say on the incombustible compounds by suggesting that it would be well to encourage, as much as possible, the consumption of lettuces and watercresses among the poorer classes of the population, who cannot afford to obtain the requisite quantity of saline matters in other forms.

Combustible compounds are gradually burnt within the organism by means of the oxygen which is taken into the lungs during respiration. A mixture of these constituents is necessary for pefect nutrition. They replace fat, muscle, and other structures, and supply the latent or potential energy which becomes converted into the dynamic or actual energy of heat and mechanical action. Thus is animal heat maintained, and internal and external work performed. Up to a very recent period, Liebig's doctrine that muscular action depended upon the oxidation and destruction of muscular tissue was accepted without question. Nitrogenous matter alone was supposed to constitute the source of muscular and nervous force, and the nutritive power of food was accordingly measured by the amount of nitrogen which it contained. At the same time, carbonaceous matter was supposed to be the chief source of animal heat. In this theory there is now found to be some truth and much error. The muscles and other nitrogenous structures of the animal body do not waste away during action any more than do the wheels and pistons of a steam-engine, and there is no incessant transformation, either in the one case or the other. It is now known that the chief source of mechanical power is the oxidation of carbon and hydrogen, and that there is an exact relation between the elimination of carbonic acid and the performance of work. The following comparison is made by Fick and Wislicenus—"A bundle of muscular fibres is a kind of machine, consisting of albuminous material, just as a steam-engine is made of steel, iron, brass, &c. Now, as in the steam-engine coal is burnt in order to produce foree, so in the muscular machine fats are burnt for the same purpose; and, in the same manner as the constructive material of the steam-engine (iron, &c.) is worn away and oxidised, the constructive material of the muscle is worn away, and this wearing away is the source of the nitrogenous constituents of the excreta." This theory explains why, during muscular exertion, these constituents are little or not at all increased, "while that of carbonic acid is enormously augmented, for in a steam-engine, moderately fired and ready for use, the oxidation of iron, &c., would go on tolerably equably, and would not be much increased by the more rapid firing necessary for working, but much more coal would be burnt when it was at work than when it was standing idle."*

It may be considered, therefore, that nitrogenous matter, as muscle, constitutes the apparatus, or machinery, which is set in motion by the oxidation of non-nitrogenous fuel.

Nothing, however, that has been said is intended to throw any doubt upon the important part which nitrogen plays in the phenomena of life; for it is certain that in the absence of this element the molecular changes which are coincident with life cannot be carried on. Its constancy, as the late Dr. Parkes has said, proves its necessity. The absorption of oxygen does not determine the changes in the tissues, but the changes in the tissues determine the absorption of oxygen, and this is equivalent to saying that without the participation of nitrogenous bodies no oxidation and no manifestation of force are possible. In the nitrogenous structures the elements are feebly combined; they are constantly undergoing changes, and arranging themselves in an endless series of fresh combina-

* Quoted by Dr. Pavy, page 100.

tions. This occurs in a prescribed order; and although the manifestation of force may be immediately due to the oxidation of carbon and hydrogen, yet the change first takes place in the unstable nitrogenous molecules, which give the impetus and direction to the combustion of other structures.*

But an instrument in constant use is constantly disintegrating, and in order that the tissues may be renovated, the used-up nitrogen must be replaced, or the gearing of the animal machine becomes deranged, and finally refuses to work.

Without entering at present more fully into the physiological view of the subject, I may say, in a word, that the true food of man consists of water, saline matters, nitrogenous matters, carbo-hydrates, and fats. These different principles are associated together in the composition of the animal body, as well as in the aliments provided by nature; and if these are not each duly represented in our daily food, defective nutrition results.

2. The question arises—What are the amounts of these several principles necessary to support life, and to maintain health and strength? Before this question can be answered, the conditions under which existence is carried on must be known, inasmuch as the waste of this or that principle varies with the circumstances under which the organism is placed. The amount of labour performed, and the degree of external temperature, are the most important factors in the calculations necessary for framing a dietary in accordance with scientific standards; but I may remark that experience had taught different communities what selection to make ages before it was discovered that the oxidation of carbon compounds serves to keep up the heat and movements of the body, and that compounds of nitrogen constitute the chief formative and reparative constituents of food. Sir Anthony Carlisle (quoted by Dr. Pavy) states, that the most northern races of mankind were found by him to be unacquainted with the taste of sweets, and their infants made wry faces, and sputtered out sugar with disgust; but the little urchins grinned with ecstasy at the sight of a bit of whale's blubber. On the other hand, the inhabitants of the tropics subsist largely upon fruits, vegetables, and other foods belonging to the group of carbo-hydrates, and they consume but little fat. In the one case the proportional amount of unoxidised carbon in the food is very large, and in the other, it is comparatively small. This distribution of carbon is that which on physiological grounds might have been predicated as necessary, so that theory and experience are here in perfect harmony. Experience has also taught us much with regard to the different qualities of food in feeding animals. The groom knows that oats are more sustaining food than grass, and beans than oats. The farmer knows that turnips and cabbage are inferior in fattening properties to oil cake and barley meal, and he puts this knowledge into profitable practice, although he may be ignorant of the chemical explanation of his success. Again, every day experience proves that the wants of the system increase, *pari passu*, with an increase in the amount of labour exacted, and that the fuel supplied must be apportioned to the work performed. So far, general experience is in accord with the results of scientific research; but the agreement is less perfect when details take the place of generalities, and when theory is appealed to for guidance in matters practical. This particularly applies to the precise quantities of alimentary substances required for given purposes. I have already adverted to the fact that up to a comparatively recent period Liebig's doctrine that muscular action depends upon the oxidation of muscular tissue was accepted without question. It is now well known that any standard of food supply based upon that theory would be too rich in nitrogen, and would therefore be wasteful and extravagant. This appears to me to show in a very striking manner the importance of attending to the teachings of experience as well as to theoretical rules, for, if experience had exercised its legitimate influence at the time that Liebig's doctrine was accepted as sound, that doctrine would have been corrected by the observation that wherever a large amount of work has to be done the diet of those performing it contains a much larger proportion of non-nitrogenous matter than where less activity is required. It might have been observed that the agricultural labourer in Scotland subsists from one year's end to the other on oatmeal and milk, while in harvest time the supply of nitrogenous matter is actually reduced by the substitution of beer for part of the milk.* It might have been noticed that railway navvies feed to a great extent on bread and fat bacon, and that fat pork, which is poor in nitrogen, is a favourite article of food with the labouring classes, while it is not relished by the rich, who, although frequently exerting themselves but little, indulge freely in butchers' meat and game. Liebig's doctrine may be said to have contradicted the accumulated experience of ages, and yet any one who might be bold enough to reject it would, ten or twelve years ago, have been looked upon as little better than a scientific outcast—a physiological heretic and infidel. The physiologist should recognise that a deeper wisdom than his own utters itself in our natural desires; and rather than attempt to dictate laws to nature, he should accept the part of interpreter, and explain that which instinct and experience prove to be true.

The figures given by Moleschott are now generally adopted as the standard by which to frame a diet for a man of average height and weight in moderate work. He gives a total of nearly 23 ounces of water-free food daily. Of this, about four ounces and a-half are composed of albuminates or nitrogenous matters, about 14 ounces of carbo-hydrates, nearly three ounces of fatty substances, and rather more than ounce of mineral matters. According to Dr. Playfair, the mean of the dietaries of the English, French, and Prussian soldiers in time of peace may be accepted as the model for full health and moderate work. In this diet the proportionate amounts of nitrogenous matter, fats, and mineral matters are less than those given by Moleschott, while the per-centage of carbo-hydrates is considerably greater. Pettenkofer and Voit give more albuminous substances and fats, and less carbo-hydrates than either; while Ranke's numbers are lower than those of any of the foregoing authorities, and he adopts a standard which is remarkable as

* Gun cotton differs from ordinary cotton chiefly by the addition of nitrogen, by which it acquires the instability characteristic of nitrogenous organic compounds.

* *Medical Times and Gazette*, Oct. 27th, 1866.

containing equal proportions of hydrocarbons and albuminates. Some persons who are inmates of a large establishment with which I happen to be connected, and who are engaged for about ten hours a day in what may be described as "industrial employment," receive 3·71 ounces of nitrogenous matters, and rather more than 17 ounces of carbo-hydrates. Now, as they thrive upon this diet, improving, as a rule, in health, and increasing in weight, it is clear that nothing would be gained by regulating their food supply by anyone of the first three-named standards, while it is certain that the money of those who subscribe to their support would some of it be wasted. If, on the other hand, Ranke's standard were adopted, they would, in some respects, be insufficiently nourished. In order to facilitate comparison, the composition of the various diets to which I have referred is shown in a tabular form.

Water-free substances given daily.	Nitrogenous substances.	Fatty substances.	Carbo-hydrates.	Mineral matters.
	oz.	oz.	oz.	oz.
Moleschott......	4·58	2·96	14·25	1·05
Pettenkofer and Voit	5·22	3·63	13·3	—
Playfair........	4·21	1·39	18·69	0·714
Vierordt	4·0	3·0	11·5	1·0
Ranke	3·52	3·52	8·47	—
"Industrial employment" diet now in use....	3·71	1·56	17.31	1·35

I am far, indeed, from presuming to say that the standards of Moleschott and other authorities are without value in the construction of dietaries; I say no more than this—that the calculations upon which they are based are not infallible, and that they can be safely used only when taken in conjunction with that continuous general observation, which is what I venture to describe as experience. Men differ in vigour; they differ in activity of vital processes, as of assimilation and elimination, and the temperature of the atmosphere by which they are surrounded, in this country at least, is continually varying. An army surgeon once wrote:—

"I have wandered a good deal about the world, and have never followed any prescribed rule in anything; my health has been tried in all ways; and, by the aids of temperance and hard work, I have worn out two armies in two wars, and probably could wear out another before my period of old age arrives; I eat no animal food, drink no wine, or malt liquor, or spirits of any kind; I wear no flannel, and regard neither wind nor rain, heat nor cold, where business is in the way."*

The intricacies of nutrition are not yet fully revealed to us, and potential energy, therefore, is not always the expression of dietetic value. Again, it has been pointed out by Dr. De Chaumont† that in estimating the amount of work performed, a correction must be made for the velocity with which it is done, and that the ratio may be generally stated as inversely as the square of velocity. There is a velocity at which the maximum of work can be done with the minimum of expenditure; this may be accepted, generally speaking, as the most useful rate of work, and it is fairly represented by walking at the rate of about three miles an hour. I may mention, lastly, that the tables giving the percentage composition of the various articles of food, from which nutritive values are calculated, somewhat vary, and this is not surprising, inasmuch as the quality of the alimentary substances examined by different analysts necessarily itself varies. Seeing then that these sources of fallacy do exist, I think I may be allowed to say that whether it be necessary to frame a new dietary, or to judge of the merits of one already in use, the guidance to be obtained from experience cannot be safely dispensed with. The human digestive and respiratory systems are, no doubt, laboratories, but they are living laboratories, and we must not loose sight of the influences of habit, of hereditary disposition, and, above all, of that power of accommodation which constantly tends to maintain a balance between daily supply and the calorific and mechanical work to be performed.

3. We must look to the organic kingdom for our supply of food, and it is generally agreed that a diet which is partly animal and partly vegetable is, on the whole, the best. While granting this, I would at the same time venture to express an opinion that undue importance is now attached to meat as the natural storehouse of nitrogen, as though albuminates in sufficient quantity were not to be obtained from other sources, or, if obtainable, could not be utilised in the system. There is, however, but little difference between animal and vegetable albuminates, for vegetable albumen, fibrin, and casein, have all a composition almost identical with animal albumen, chondrin, and casein, so that the two classes of foods are interchangeable, and it is manifest that they serve the same purposes in the animal body. The late Dr. Parkes remarks that well fed corn-eaters, or even well fed rice and pea eaters, show, when in training, no inferiority to meat eaters. Dr. Bruce Thomson called attention, some years ago,* to the satisfactory condition of the convicts at hard labour in the general prison at Perth, and to the fact that meat entered but very sparingly into their dietary. He also mentions that the diet of Scotch agricultural labourers is composed of oatmeal and milk, to the exclusion of butchers' meat, and he adds that they are the best fed out-door labourers in the United Kingdom. He thinks (though for my part I do not here agree with him) that the objection entertained in England to oatmeal has been derived from Dr. Johnson, who defined oats as "a grain which in England is usually given to horses, but in Scotland supports the people."

There is ample and unexceptionable evidence, as Dr. Carpenter has said, that, where neither milk nor any of its preparations is in ordinary use, a regimen consisting of bread, fruits, and herbs is quite adequate to the wants of a population subsisting by severe and constant toil. This evidence is to be gleaned from the dietetic habits and physical condition of the Russian peasants; of the greater portion of the population of Greece, and particularly of the Greek boatmen and sailors; of

* Quoted in Hinton's "Thoughts on Health."
† "State Medicine," pages 145 and 148.

* *Medical Times and Gazette*, Feb. 1, 1868.

the entire population of Japan; of all the lower classes in China; of the high caste Hindoos; of the labouring classes in Egypt; and of numerous tribes, or classes, in America, as, for instance, the Indians of Mexico, the copper miners in Chili, and many of the Spaniards in South America. We may conclude, therefore, that the vegetable kingdom is perfectly capable of supplying the wants of man under a great variety of circumstances.

The active, patient, indefatigable Chinese labourer subsists mainly upon vegetable produce; he lives and works hard upon what an Englishman would starve upon, and he is accordingly able, in some parts of America and Australia, to run the European labourer very hard. I would submit that this and many other examples, that I have not now time to enumerate, tend to show the extent to which our requirements depend upon habit, and upon the degree to which we indulge in or control our appetites. The ancient Scotch* are said to have developed a taste for shepherds, whom they preferred to their flocks, and we know that cannibalism is still practised in the Polynesian Islands, where Negroes are still in request. When we hear that the ancient Persians lived a good deal on watercress, we naturally connect in our minds their physical inferiority with the poverty of their diet; but finding, on the other hand, that the Romans, in the best period of the Republic, largely sustained themselves on turnips, and that degeneracy came in as turnips went out,† we are are compelled to reconsider our opinion.

An Irish labourer looks to bulk, and prefers a dinner consisting of half a stone of potatoes, with a little bacon or herring, to food in smaller bulk, even though it be more nutritious, and this is said to explain the circumstance that there is often, at first, a falling away in the condition of the inmates of prisons in Ireland, coupled with the inaptitude for labour, but that after a time the system seems to recover. A digestive apparatus habituated to deal with vegetable food, does not at once furnish the secretion necessary for the digestion of food derived from the animal kingdom; and *vice versa*, sudden changes of diet should, therefore, if possible be avoided.

We possess a rich store of albuminoids, or flesh formers, in the pulses, or peas, beans, and lentils, which are largely consumed in Europe, North Africa, and India, and are, unfortunately, much neglected in England. The ratio of flesh-formers and heat-givers in these seeds is about 1 to $2\frac{1}{2}$, instead of 1 to 5, as in wheat, or 1 to 10 as in rice.‡ The meal of the lentil, or *Ervum lens*, is of extreme richness, containing more casein than either peas or beans, yet it is to be obtained in England only under fanciful names, generally mixed with barley flour, and sold at many times its value. Notwithstanding, however, the price charged, I think that those who patronise these preparations may read with some satisfaction the following verses out of the prophet Daniel:—

"Prove thy servants, I beseech thee, ten days; and let them give us pulse to eat and water to drink; then let our countenances be looked upon before thee, and the countenance of the children that eat of the portion of king's meat. . . . . And at the end of ten days their countenances appeared fairer and fatter in flesh than all the children which did eat the portion of the king's meat. Thus Melzar took away the portion of the meat and the wine they should drink, and gave them pulse."

* "Chambers' Book of Days."
† Hinton, Op. Cit. p., 120.
‡ "Food; some account of its sources, &c." By A. H. Church, M.A., Oxon. (Chapman and Hall)

I would call attention to the accuracy of the prophet in his use of the term "fatter in flesh," for the flesh-yielding as distinct from the fat-yielding qualities of the food are those for which it is chiefly remarkable.

We have in the cereals a rich store of nutrients not as yet fully utilised, and I will venture to ask the attention of the Society for a few moments to the important subject of bread. The fact that bread was called by the ancients the "staff of life" indicates that in the olden time it was a different article to that now supplied by the ordinary British baker. It doubtless contained the albuminoids, fats and mineral matters necessary to make blood and tissue, and to build up the frame. To this day the wandering Arab lives by choice almost entirely on bread; with a few dates as a relish, but then he bruises his own corn, and bakes his own flour, and thus supplies himself with nutrients which we, in London, obtain by having recourse to foods of animal origin. A recent and very able writer in the *Pall Mall Gazette* states that "the yeomen of Elizabeth's reign, who drew their bowstrings to their ears, and sent a cloth yard whistling through a barn door at 80 yards, ate meat about once a week, and lived the rest of the time on bread and cheese. And the servant of the last century, who often had to do battle for his master with highwaymen, was a tough fellow, though his nourishment was beef on Sundays only, and a thin mutton soup on other days with bread—but good bread."

The wheat grain is a fruit, and consists of a seed and its coverings. The central portion of the grain is chiefly composed of starch, but also contains nitrogenous and mineral matters. Around this centre portion is a layer of angular cells, rich in nitrogen and fat. External to this are the inner and outer envelopes of the seed. These yield mill products of different qualities which, in large mills, are usually classified as follows:—Tailings or toppings, middlings, coarse and fine sharps, pollard, bran. They are all much richer in nitrogen, oil, and mineral matters than the central or floury portion of the grain; but the outermost or branny layers contain silex, and are less digestible, and therefore less nutritious than the parts of the grain which they enclose. The flesh formers in white bread amount to seven or eight per cent., according to the quality of the wheat of which it is made. In bread containing the envelopes they amount to about 10 per cent. Experiments upon animals have proved that they can live upon brown bread without any other food; but if fed upon white bread alone, the health first suffers, and death finally ensues.

"Brownish bread," says Dr. Brinton, "of simple wheat meal, with even an admixture of a fourth or fifth of rye, would, for equal money value, give the labouring population a food incomparably more abundant and nutritious than that which they now make use of as pure white bread; and in no way could the dyspeptic affluent set their poorer neighbours a better example than by adopting, were it at some little pains, a bread which might sometimes cure their own ailments by its mechanical quality, as well as prevent disease and

deformity among the lower classes by its nutritive value."

The following passage occurs in Dr. Prout's clinical work on "The Nature and Treatment of Stomach and Renal Diseases," fifth edition, page 43:—

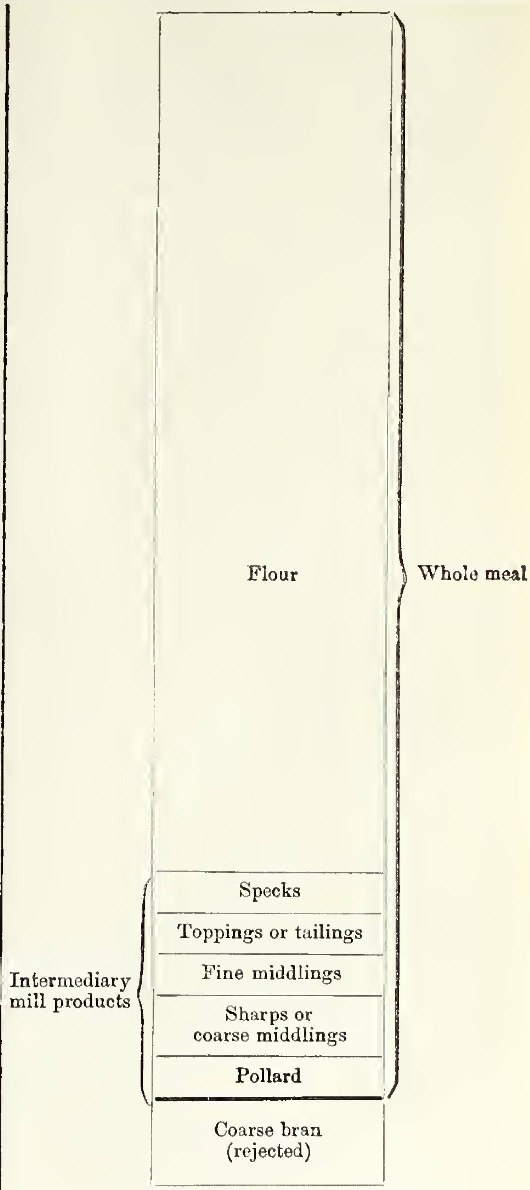
"Bread, therefore, made with undressed flour, or even with an extra quantity of bran, is the best form in which farinaceous matters can be usually taken in most of the varieties of dyspepsia, accompanied by obstinate constipation. This is a remedy the efficacy of which has long been known and admitted; yet, strange to say, the generality of mankind choose to consult their taste rather than their reason, and, by officiously separating what nature has beneficently combined, entail upon themselves much discomfort and misery."

Liebig states* that "many millions more men could be daily fed in Germany if it were only possible to persuade the population of the advantages which bread made of unbolted flour has over that which is ordinarily eaten." Numerous other authorities might be quoted to the same effect.

By utilising a portion of the coverings of the wheaten grain, we should be materially assisted in introducing an adequate proportion of nitrogen, as well as of phosphates and other mineral matters, into our dictaries at a low cost, inasmuch as we should obtain the required constituents in the inexpensive form of coarse and fine "pollard," "middlings," and "sharps," and should thus be enabled to draw less largely than would otherwise be necessary upon the most expensive article entering into any dictary—that of butcher's meat. The brown bread usually made and sold by bakers is nothing more than white bread with a sprinkling of bran; it contains, therefore, the least valuable covering, and the more nourishing sharps and middlings, &c., are excluded. I would recommend that the coarse bran be always rejected, and that the bread be made of the remaining mill products, in their natural proportions. These products together I would describe as "whole meal," as being a term which implies the separation of the outer lamellar and highly siliceous envelope of which the coarse bran is composed. This constitutes about 5 per cent. of the product of grinding, and I exclude it as being, in some cases, difficult of digestion, and apt to set up irritation of the alimentary canal. The composition of the meal, and the precise meaning of the term "whole meal" (as distinct from "whole wheaten flour," and other like terms) may, I think, be clearly shown by the simple diagram in the next column.

If, in the manufacture of bread, the whole meal be subjected to the same treatment as ordinary flour, the result will be a somewhat heavy loaf, owing to the presence in all the envelopes of a ferment termed "cerealin." This ferment is analogous to the diastase of malt, and, under certain conditions, exerts a peculiar influence on starch, giving rise to a compound of dextrin and sugar which, by its viscidity, prevents the dough from being sufficiently puffed up by the carbonic acid generated in the process of fermentation. In order to avoid this inconvenient action of the cerealin it is necessary to make the sponge and dough of flour only. The middlings, &c., should not be added until the dough is nearly ready to be baked, when

* *Lancet*, January 23, 1869.



the whole should be kneaded together quickly, weighed off into loaves, and baked in the usual way. The reason for keeping the intermediary products apart from the dough until the latter is nearly ready for the oven is, that the period of incubation is then so short that the leavening action of the cerealin does not take place, and the bread produced is light and porous. A process resembling this, but somewhat more complicated, is already in use in Paris, and was introduced by M. Mège Mouries, who first discovered the existence and properties of cerealin, and suggested that the intermediary products should be kept apart from the dough until the latter is nearly ready for baking.*

* See Ency. Britt.: New Edition, Art. "Baking."

But, irrespective of any particular process of manufacture, I would remark that it is of national importance that the labouring man should be able to obtain a good and unadulterated article for himself and his children. The flour of the present day is too often adulterated with bone dust, porcelain earth, powdered gypsum, and other ingredients; the baker may add alum and sulphate of copper to produce whiteness; he frequently uses boiled rice to increase the yield, and thus the quality of the bread, as a life-sustaining food, is still further reduced. The adulteration of bread adds seriously to the expenses of housekeeping among the poor, who formerly depended chiefly upon bread for nourishment, but now consume it less and less. This is said, by the writer just quoted, to be noticed also in France, which till now has been a great bread-eating country. He adds that he does not advocate a diet entirely of bread, but only the purification of bread, that it may be restored to its proper function as the staff of life to those who can ill afford fancy props. "Let those," he says, "who please buy dear meat and bad butter; but let those who desire to live largely on bread be enabled to do so. It might be done, if half the attention which is paid to checking the adulteration of beer were bestowed on stopping the poisoning of the loaf. Beer has become pretty good from being constantly looked after. The great brewers have a character to lose; a prosecution would ruin them; so they send out barrels of drinkable liquor, and any gentian root, salt, sugar, or soda, which may be subsequently added, is the work of the publican selling by retail over his counter. Anybody can get good beer by purchasing it in the cask direct from the brewer; but anybody cannot secure good flour by getting it direct from wholesale millers, who are on their guard, and refuse to supply any but the 'trade.' The well-to-do, who patronise fancy bread at fancy prices, are treated to as much adulteration in their flour as the poor; their breakfast rolls are whitened with alum, which is an astringent, hindering the digestion, and which also, be it noted, acts as a corrosive on the teeth, causing the enamel to decay prematurely. The rich, however, have only themselves to blame if their bread is not pure wheaten; for pure wheat yields a greyish loaf, and if whiteness and sponginess be insisted upon, they can only be obtained at the expense of quality." The poor "do not prosecute their bakers, because they cannot afford to do so. . . . . It would cost several pounds to institute a prosecution, and, after all, it would not reach the real offender. A baker knows, of course, that his flour is adulterated, but if he sold pure bread he would have to raise his prices to compete with unscrupulous rivals. . . . . Thus, we turn in a vicious circle, and it becomes manifest that the millers are the persons who should be brought to book. Public analysts ought to visit millers' sacks as vigilantly as they are beginning to inspect milk, and, after this, they should overhaul the loaves in the baker's shop. . . . . How excellent pure bread is, all who have tasted a home-made country loaf know. It remains fresh a fortnight after baking. It requires no condiment to make it acceptable, but supplies an all sufficient meal to the hungry man, without cloying the stomach or ever tiring the palate. A very different substance this from the heavy city-baked half-quartern. . . . . . No man ever derived strength from this burlesque of bread; and the city child, who has learned to think poorly of it from his infancy, naturally grows up to think that the prayer for 'daily bread' sums up but a small part of man's needs in respect of diet." *

A simple mode of increasing the per-centage of nitrogen in a dietary, to which but little attention has been paid in England, would be to wash out some of the carbonaceous or starchy matter, as is done on so large a scale in Italy in the manufacture of maccaroni and vermicelli, and many other pastes. The starch is a valuable commercial article, and is therefore not wasted.

I would here call attention to maize, or Indian corn, as an article which affords a large amount of nutriment at a cheap rate, and the use of which should, therefore, be encouraged as being a most valuable addition to our food supply. It cannot be manufactured into bread, on account of its deficiency in gluten, unless mixed with wheat, or rye flour, but it can be made into cakes, which when roasted are very palateable, and are largely eaten both in the United States and in Spanish America. The article of food so largely used in northern Italy under the name of polenta is an Indian meal pudding, and this dish is now so much appreciated in many districts of the west of Ireland as to be gradually displacing the potato. The flavour of maize is sometimes considered harsh by those who are not accustomed to it, but this objection may be entirely avoided by using it in combination with oatmeal. A most nutritious and digestible porridge, or stirabout, may be made by an admixture of the two meals, but inasmuch as Indian meal takes rather a longer time to cook than oatmeal, some little care is required in manipulation. Maize contains about the same proportion of flesh formers as wheat, and three times the amount of fatty matter, so that it stands high in the grass order, or *Graminaceæ*, in point of nutritive value. Now, as the diet of the poor is liable to be deficient in fat, and as the introduction of a due proportion of this important aliment into the dietaries of workhouses, prisons, schools, reformatories, asylums, and other public institutions, is a matter which is frequently attended with difficulty, I would submit that Indian corn is worthy of more attention than it has yet received. Before quitting this subject, I may mention that the much advertised preparations sold under names intended to imply some connection with or derivation from Indian corn are mere washed out substances which are destitute of the materials necessary for the formation of bone and flesh.

In the slaughtering of animals much blood is wasted, which, if saved, would furnish a food scarcely less nutritious than flesh itself. It has been supposed† that the objection to eating blood is based in some degree upon the Levitical law: "Ye shall eat the blood of no manner of flesh; for the life of all flesh is the blood thereof: whosoever eateth it shall be cut off;" but it may be doubted whether this prohibition has any weight in these days. It was one which the Jews themselves could not obey, inasmuch as it is impossible, by any mode of slaughtering, to extract all the

* *Pall Mall Gazette*, Feb. 8, 1878.
† "Dr. Smith on Food." Page 84.

blood from the body. The value of blood as a food may be gathered from the table to which I have invited attention, and I am not aware of any good and valid reason why it should not be cooked and eaten.

If time permitted, it would be easy to point to other neglected foods, but I must content myself with having merely indicated what is to be done in this direction, and I will now venture to state, as a distinct proposition for the consideration of the Society, that the tendency in modern times is to attach too much importance to meat as furnishing the chief formative and reparative food compounds, and that the displacement of vegetable by animal nutrients to the extent which is now common in the dietaries alike of private individuals and public institutions is wasteful, and apt to be injurious to health. The prominence now given to the various meats may, no doubt, be traced partly to the doctrines laid down years ago by Liebig, who, as I have already stated, taught that the nitrogenous constituents of food alone supplied the materials of growth and repair, and gave to animal food the first and most important place in the construction of dietaries. How far increasing wealth and the habits of a luxurious age may have operated to bring about this change, it is not for me now to inquire; but it cannot be doubted that the excess of animal albuminoids now consumed by many classes of society is not only wasted, but that the abnormal activity of the processes of deoxidation and excretion rendered necessary by this excess, imposes an undue amount of work upon important organs, and especially upon the liver and kidneys; that the competency of these organs is eventually injured, and that a train of evils then follows from the accumulation of imperfectly oxidised *débris* in the system.

I will not now attempt to deal with a subject of such enormous scope and vast importance as the effects of the accumulation and deposit of waste products in the human organisum, and I will pass on to consider for a moment the subject of the cost of meat in hospitals and other institutions. It is stated by Dr. Steele, the Medical Superintendent of Guy's Hospital,* that the cost of butchers' meat in hospitals is three times that of any other aliment employed in the diet of the sick, and it is well known, that in all institutions the outlay thereon continues to increase from year to year. It is, therefore, a question for serious consideration, whether any means can be found to moderate this outlay by diminishing the amount hitherto thought necessary for invalid requirements, and to compensate for that loss by the substitution of other foods of an equally nutritive but less costly character. In attempting a change of this kind, the main difficulties would, in all probability, arise, as Dr. Steele remarks, on the part of the patients themselves, who are accustomed to look upon animal food as their mainstay in illness, and who eagerly expect to obtain in hospitals luxuries which their position in life permits them to obtain only occasionally in their own homes.†

As meat is costly, it should be turned to the best account, and the careful preparation of this and all other foods is a matter of so much sanitary importance, that it should not be looked upon as a subject only for the gourmand. Yet, treatises on food and digestion are written; the phenomena of nutrition and the diseases of mal-nutrition are carefully described; standards and scales of diet are drawn up; and the cook, upon whom so much depends, receives but little chemical and physiological instruction. I am not presuming to deliver a lecture upon cookery, and will not, therefore, attempt to enter into details; but I would venture to remind the Society that cooking is as much a science as an art, and that, for want of a due recognition of this fact, vast quantities of food are wasted, or rendered unwholesome. If as much scientific attention had been paid to cooking as to brewing, the old saying, that a cook is born and not made, would long ago have been forgotton, instead of being very generally and helplessly accepted as an expression of a fact.

How, I would ask, can a cook, who is ignorant of the important part which mineral matters play in the economy—who does not know that the salts enumerated in the table showing the composition of the blood, and weighing only a few grains, are as essential to nutrition as the ounces or pounds of flesh in which they are naturally found—how can such a cook be expected to adopt processes by which these few and precious saline matters may be retained? How little is known by ordinary cooks of the behaviour of animal albumen at different temperatures—how it coagulates very slowly at a temperature of 140 deg. Fah., and very rapidly at 212 deg.—and yet how all-essential is this knowledge, in order that the nutritious properties of food, and particularly of animal food, may be fully secured! I have frequently seen in public establishments, in which soup is an important feature of the diet, the meat, bones, and vegetables simmering or boiling all together for hours, the result being that the meat for nutritive purposes has been destroyed, though its presence in the soup or stew, in the form of minutely divided fragments of muscular fibre, is pointed to with some exultation as a proof that the meat is "all there," and that the soup must, therefore, be nutritious. The meat is certainly "all there," but its albuminous principles are effectually sealed up and plaeed out of reach. When the soup cools, a spoon will stand upright in it, just as it would in a pot of glue, and this erect attitude of the spoon is to this day considered by many as an infallible proof that the soup is nutritious in the highest possible degree, whereas it is only a proof that it is highly gelatinous. I do not presume to assert that gelatine is wholly without dietetic value, but it is admitted by its stoutest defenders that it will not serve as a substitute for the albuminoids.

Before quitting this branch of my subject I would venture to raise a question as to whether

* Guy's Hospital Reports, 1873.

† I would here ask attention to an interesting table extracted from an article by Baron Liebig, which appeared in the *Lancet*, of March 13th, 1869, showing the cost of one pound of albuminate in different kinds of food calculated upon the prices prevailing at that time in London:—

			d.
One pound albuminate in	cheese costs	....	20
Ditto ditto	milk ,,	....	35
Ditto ditto	meat ,,	....	42
Ditto ditto	eggs ,,	....	113
In vegetables:—			
One pound albuminate in	flour costs	....	7½
Ditto ditto	peas ,,	....	5
Ditto ditto	potatoes costs	....	38

baking meat, which is now practised on so large a scale in some clubs, as well as in most hospitals, restaurants, and other large establishments, is a satisfactory mode of cooking a joint. The temperature employed is frequently too high, and the empyreumatic products, or volatile fatty acids, which are generated, having no means of escape, saturate the meat, and render it ill-flavoured and indigestible. At the end of the process the cook places the overbaked meat immediately before the fire in order to brown the outside, and to produce a fraudulent appearance of roasting, but this still further imprisons the unwholesome products which have resulted from charring in the oven, and the result is not usually satisfactory. Dr. Chambers, in his excellent work,* maintains that no kitchen is complete without an open range, and that it is impossible to have a properly roasted joint by any other means, as he learnt "by visiting the private premises of a "patent kitchener" manufacturer, and finding there an old-fashioned fire-place in full operation. He cared too much for his dinner to employ his own works. Experience leads Dr. Chambers to question even the economy of the close fire in practical working.

But the preparation of food for the stomach does not end with cooking. The solid portions of the food must be properly masticated, and the evils resulting from imperfect mastication are so serious that I may perhaps be excused for briefly drawing attention to them. The subtle changes of alimentary substances that are collectively called "digestion," are commenced in the cavity of the mouth, where the food is finely divided, and is so intimately mixed with fluids as to be converted into a pulp which can be easily swallowed. There are four pairs of large salivary glands, and numerous smaller glands whose ducts are scattered thickly beneath the mucous membrane of the cheeks, soft palate, and at the root of the tongue. The flow of saliva, which never ceases in health, is much quickened by mastication, and is also greatly accelerated by mental impressions, as, for example, by the view of wholesome food, which makes the "mouth water." The mechanical purposes served by the saliva are probably not of greater importance than the chemical part which it takes in digestion, especially that of transforming starchy matters into soluble dextrin and grape sugar, thus rendering them fit for absorption. If mastication be partially or wholly omitted, the first stage of digestion is not completed, and the subsequent stages or more or less abortive.

A medical gentleman of my acquaintance, an acute observer, and a man of great scientific attainments, whose evidence is valuable, was for some years subject to sub-acute attacks of rheumatism, which completely laid him up once or twice every year, and he always believed his attacks were due to taking cold. About 12 months ago he visited a dentist, who informed him that his molar teeth were defective; that they were not placed in apposition in the upper and lower jaw, and that he consequently must have bolted his food. My friend replied that he was not conscious of any defect in mastication; nevertheless he took the dentist's advice and was supplied with a double set of molars. After becoming accustomed to them he masticated every morsel vigorously, and observed that the time spent over his meals was much longer than before. He has never since been troubled with any sign of rheumatism, and has gained 4 lbs. in weight; he assures me that he now feels himself to be quite a different being, and that he has not been so well as he now is for many years. The explanation of what has occurred is that the process by which his teeth became inefficient was gradual, and that his partial omission of mastication was not observed; imperfect digestion and assimilation followed; incompletely oxidised and organised materials accumulated in his system, and thus the rheumatic diathesis was developed. He derived no benefit from alkalies, salicin, warm clothing, change of climate, or any other remedies adopted; but when, at last, the cause of his malady was removed, the effect at once disappeared.*

And now that the brief hour allotted to me has expired, I feel that I have undertaken more than can be achieved within the limits of a single paper. I see that I am still but on the threshold of a subject, the boundaries of which are ever illusory, mysteriously melting into distance just when their searcher persuades himself that he descries their outline. In order to treat intelligibly of dietaries in their practical and economic aspects, it is indispensable, in the first place, to take a general survey of the subject, to ask questions which are necessarily questions of principle, for who can rear a superstructure without laying a foundation, and of what use is a foundation unless materials be provided with which to build? I am far indeed from presuming to say that adequate preparations have been made in this paper for the architecture of dietaries; on the contrary, I feel that I have penetrated but little below the surface, and that my building materials, thus far, consist of but a few fragments unshaped, and thrown but loosely and promiscuously together. As the subject, however, cannot be pursued farther on the present occasion, I can only ask for the indulgent consideration and discussion of what has now been said, and will take some future opportunity, if the Society should deem the subject of sufficient interest, of bringing under review the dietetic habits and resources of different classes of the community; the requirements of youth and age; of the different kinds of idlers and workers; the errors committed; and the means by which they may be avoided. I will now, with your permission, briefly summarise the contents of this paper, and, in so doing, supply one or two omissions.

We are taught, then, by science and experience that the nitrogenous, oleaginous, saccharine, and mineral constituents of food must all be duly represented, and that the absence or even deficiency of any one of them is incompatible with vigorous growth and the maintenance of perfect health.

Granting that a mixed animal and vegetable diet is well suited to the climatic conditions of this country, the proposition, however, is stated that, whether the albuminates and fatty matters be obtained from the animal or vegetable kingdom is not a matter of primary importance. It has been

* "Diet in Health and Disease, p. 88."

* In this case the lactic or rheumatic fermentation was probably brought about by the katalytic action of imperfectly digested and decomposing nitrogenous substances. (See case reported by Dr. Moss, R.N., *Lancet*, January 2, 1875).

pointed out that we should learn to change our diet with seasonal variations; for to live, as many of us do, very much in the same way both in summer and winter is as unreasonable, and may be, in its degree, as fatal as it would be for an Esquimax to endeavour to sustain himself on a diet suitable to the tropics, or for an Indian to feed on the flesh of the walrus and whale blubber. If more care were exercised in this particular, there would be less autumnal diarrhœa, which is due in many cases, not to eating fruit, but to the accumulation in the system of superfluous material, for which there has been no natural demand, and which is liable to be a source of disease so long as it continues to overload the circulation. With regard to the dietetic importance of fresh vegetables, I will only repeat that their omission is attended with a fearful deterioration of the blood, and that their diminution below a certain point results in a train of evils which are apt to be ascribed to other causes. As to the total quantity of food necessary for the maintenance of health, I have said that our most valuable practical rules are furnished by experience and not by theory, and that the part which can be most appropriately accepted by science is not that of dictator, but rather that of interpreter.

I must reserve what I have to say on the subject of alcohol and the other food-adjuncts for that future opportunity which the Society seems so generously willing to grant me. With reference to the use of alcohol, I will only now remark that in the discussion of this subject too much reference appears to me to be made to a theoretical standard; the great difference between individuals, and between the requirements of the same individual at different times are, in my opinion, too much lost sight of. We are, no doubt, all agreed as to the injurious effects of immoderate indulgence in alcohol, but then, what is moderation to one person is drunkenness to another. There is no fixed standard by which to be guided, and so we must be satisfied with an approximation to the truth, and that approximation is to be deduced very largely from personal experience. Nothing varies so much as the key in which the nervous organism is strung. Those whose sensibilities are excessively or even morbidly delicate know, to their cost, how—

> "Dearly-bought the hidden treasure
> Finer feelings can bestow;
> Chords that vibrate sweetest pleasure
> Thrill the deepest notes of woe."

These organisations are peculiarly liable to suffer from the evil influences of alcohol, while others, differently tempered, resist its power. The poet, describing the various effects of wine, truly says:—

> "Brisk wine some hearts inspires with gladness,
> And makes some croop in sober sadness;
> Makes politicians sound to battle,
> And lovers of their mistress prattle;
> While, with 'potations pottle deep,'
> It lulls the serious sort to sleep."

The attention of the Society has been directed to the subject of neglected sources of nitrogen, and to the importance of turning food to the best account by modes of preparation in accordance with natural laws. I may, perhaps, venture here to interpolate the suggestion that much good might be done by giving cooking utensils to the most deserving among the poor, and by instructing them how to make use of them in their own houses. Money given for this purpose is likely to be diverted to other, and perhaps less wholesome uses; and a lesson in cookery, to be really serviceable to the wife of a labouring man, must be given to her in her own poor room, where she can be taught, with some prospect of success, how to make the most of scanty resources.

And now, if I refer once again to the evils of over indulgence in eating and drinking, it is because it appears to me that the physiological teaching of the present day tends to increase a danger already sufficiently great—that, namely, of exceeding the actual requirements of the system. It is now laid down in most of the leading works on physiology and dietetics that a man in health, taking moderate exercise, requires daily an amount of nutriment that may be fairly represented by 2 lbs. of bread, and 1 lb. of uncooked meat, and I think I may appeal to experience as showing that this is too high a standard for such an amount of exercise, or work, as, in the ordinary use of language, would be described as moderate. To insist upon such a standard appears to me to increase the difficulties, both of those whose means enable them to indulge their appetites without stint, and of those who cannot obtain enough to maintain health and strength. Men often blame their ancestors for disease which is, in reality, due to the consumption of nutriment which is not required. Matters which are oxidisable do not become oxidised, nitrogenous waste takes the form of uric acid instead of the more highly organised urea, and thus the whole class of disorders called gouty may be generated. Too much variety every day at dinner is often to blame for this, inasmuch as the appetite is unduly stimulated. And here, if I may venture to say so, a gastronomic, as well as physiological mistake is committed; for dining as Walker says, in the "Original," is an everyday occurrence, or nearly so, and when great variety is constantly attempted at the same meal there is apt to be a great sameness at different meals. What is wanted is variety at different meals, for the differences in the productions of the different seasons and of different climates, point out to us unerringly that it is proper to vary our food; and one good rule by which not only to maintain health but fully to secure and enjoy the variety provided by nature is to abandon everything out of season. When, however, I read a modern *menu*, I am sometimes reminded of the lines in Ben Jonson descriptive of luxury:—

> "My meat shall all come in in Indian shells,
> Dishes of agate set in gold, and studded
> With tongues of carps, dormice, and camels' heels,
> Boiled i' the spirit of sol and dissolved pearl;
> Apicius' diet 'gainst the epilepsy;
> And I will eat these broths with spoons of amber,
> Headed with diamond and carbuncle;
> My footboy shall eat pheasants, calver'd salmons,
> Knots, godwits, lampreys; I myself will have
> The beards of barbels served instead of salads;
> Oil'd mushrooms. . . . .
> We will eat at such a meal,
> The heads of parrots, tongues of nightingales,
> The brains of peacocks and of ostriches
> Shall be our food, and could we eat the phœnix,
> Though nature lost her kind, she were our dish."

But I would not have it supposed that because I am alive to the evils of excess, I am oblivious of the corporeal and mental degeneration which result from a deficient diet. I know well that

famine breeds crime and pestilence, and that where food is deficient—

> "Age and youth, their landmark ta'en away,
> Look all one common sorrow." *

I know that good food is one of the means of health, and to good food must be added temperance. The elaborate mechanism by which we move, and feel, and think, and act, which excited so much astonishment in the minds of the first anatomists, and which, perhaps, astonishes still more the modern physiologist, has a marvellous power of self-adjustment; but it may be put hopelessly out of gear by continued ill-usage, whether it be that of undue abstinence or that of excess. Liebig has it that he who has learned the art of living according to fixed principles has learned something of the art of prolonging life. "Even the act of eating and drinking may teach us that we are under the influence of natural laws which act upon our bodily condition, and, as a consequence of such influence, upon our acts also. A knowledge of natural laws contributes to make man what he ought to be; they determine the rank he holds above the other animals; and it is just this in which their value lies."† Old Isaak Walton says that "he that loses his conscience has nothing left that is worth keeping. Therefore be sure you look to that. And in the next place, look to your health; and if you have it, praise God, and value it next to a good conscience; for health is the second blessing that we mortals are capable of, a blessing that money cannot buy; therefore value it, and be thankful for it." Health is indeed worth preserving; it is the soul that animates all enjoyments of life, which fade, and are tasteless, if not dead, without it.

DISCUSSION.

Mr. Hale said he had been very much interested in the paper, and should like to know, with regard to the question of temperature, whether a person living in a very high temperature would still require less food than one living in a lower temperature, or whether the waste of the body under such circumstances would not be greater?

Mr. Cooke said the paper had not dealt with one point he thought of some importance, namely, the proper cooking of meat. It was well known that meat, especially pork, insufficiently cooked, was very unwholesome. He believed a great many watercresses were consumed in London, and there was now a good supply; but that was not so some years ago. He also referred to a book on this subject by the late Dr. Andrew Combe, which contained an account of the experiments made by Dr. Beaumont in America on the action of the gastric juice.

Dr. Mann said it would hardly be possible to add anything to the paper they had heard, which was so complete, as far as its range went. He fully agreed, from his own experience, with Dr. Gover as to the great excess often practised in the amount of food taken, and he might illustrate that by stating that throughout all the large districts of South Africa the natives who were employed by the whites were fed almost exclusively on a diet consisting of three pints of ground Indian corn per day. They very frequently got no meat whatever, and the best families not more than about six pennyworth per head. Upon that diet of nearly 3 lbs. of maize their health and strength was abundantly sustained. He would also endorse the statement that fixed diet did not do for everyone, but required to be largely modified under special circumstances. He also agreed that they should be very careful as to the influence produced by experience. They must attend to experience to modify the rules just before them; but the great difficulty was that experience was not allowed fair play. They had their appetites stimulated by palatable food prepared in an attractive form, and above all things by alcoholic stimulants. He had no doubt himself that many of his friends would be entirely unable to clearly see the bearing of experience, and to say what was a fit limit. He was quite sure that the great difficulty with alcoholic drinks was the temptation which they themselves afforded to excess. He himself took them very moderately, not because he thought they were necessary, but because they were pleasant, and occasionally, perhaps, he gained a little advantage from their use; but even he, taking this view, found he was obliged to take very much less than the allowance ordinarily made. In illustration of that, he might refer to the admirable lecture recently published in the *Times* from Dr. Carpenter, wherein he laid down as the limit of safety that you should not, under any circumstances, use alcoholic drinks which would allow more than one 500th part of alcohol to be present in the circulating fluid of the system. According to his own experience, the limit was too large, and that was an illustration of the caution necessary. Anyone who used fermented drinks habitually would be almost certain to lose the power of experience which he required to guide him, and, therefore, extra care was needed. He hoped this point would be further developed hereafter by Dr. Gover.

Mr. Trewby said he had been long ago impressed with the view that too much meat was generally eaten, and he did not allow his children to take any up to the age of seven. They were remarkably healthy and strong, and from about four years of age were accustomed to walk eight or ten miles a day. He thought that people of sedentary habits should not take more than half the allowance mentioned, of 2 lbs. of bread and 1 lb. of meat per day. His experience of alcohol was that it was rather noxious than beneficial. One point had not been insisted on, viz., that people did not require to eat and drink at the same time. If people were hungry, they should eat and drink if they required it; but if they could only get out of the habit, they would often find that they were not thirsty at the conclusion of a meal.

Mr. Stiff asked if the capacity of digestion varied as much in human beings as in some animals. In a recent visit to the Jardin d' Acclimation at Paris, he was much struck by the mechanical process of fattening fowls; and he noticed that under each bird was a ticket, giving the amount of food which it could take at once; and there were great differences, for while some could take 10 centilitres at a time, others would take 14 or 16. He asked the director if it depended on their age, and was informed that it was not so, but was purely a question of the individual capacity of digestion. They were all put in at the same age, and kept there for the same time, which was from 16 to 20 days.

Dr Braddon having expressed his high appreciation of the paper, asked what was Dr. Gover's opinion of meat as a stimulant, pure and simple. He was told that when persons not accustomed to meat were given it, it acted upon them exactly like an alcoholic stimulant. He should also like to know his opinion with regard to vegetarianism; whether it was possible to maintain mental and bodily vigour on a purely vegetable diet. His own experience was that such people were not so strong as those who took a mixed diet.

The Chairman, in proposing a vote of thanks to Dr. Gover, said he had taken up a subject which came home to everybody; for, whether Duke or dustman, a great part of their expenditure went in food, either their own

* Dryden.
† *Lancet*, March, 1869.

or some one else's. He was under the idea that a great deal of that expenditure was generally wasted, to a large extent from people not knowing how to make the best use of the food they obtained, and what were the best materials to use, and also, to a large extent, from imperfect cookery. It was a curious thing that it should be so in England, which of all countries in the world, was most dependent on others for the supply of its food materials. Something like 44,000,000 cwt. of flour came into this country every year, which would represent about half the food of the population in that item. Of course, there was a large amount of meat and other matters also imported. The only way to correct this great national defect was by scientific knowledge of the subject, and by the propagation of true doctrines on the matter. Science, to be of use, must be founded on and corrected by experience; they must not be too dogmatic, but must allow their theories to be corrected by practice. An example of what science must do in correcting practice was afforded by the whole meal bread to which Dr. Gover had alluded. The poorer part of the population were exceedingly particular in having perfectly white bread, and all the resources of art and science were devoted to making it white by all manner of chemical expedients, including the introduction of alum; whereas, in fact, the bread thus produced was far less nutritious than if they took the natural material as they found it. A great saving would also be effected if less alcoholic liquors were drunk. He was not an advocate for total abstinence, but there was a long step to be taken between total abstinence and the amount of drinking that now went on. He did not believe that sudden total abstinence from drink would do anyone any harm, as was sometimes suggested. There was a large class on whom they were practically able to try the experiment, viz., the inmates of prisons, who formed a floating population of 30,000, who never touched any alcoholic liquor, except they were ill, and he never knew that they were any the worse for it. As to how these improvements were to be introduced, he should look mainly to the medical profession as the proper apostles of this kind of thing. If they would take in hand the dietary of the people they might do a great deal of good, and save the necessity of a great deal of medical treatment. Another way in which they might do good would be by supporting the introduction of the schools of cookery, which were commenced four or five years ago at South Kensington, and which now promised to take root all over the country in connection with the Board Schools. There was nothing, he thought, in which education could be more practically useful than in teaching people how to make the best use of their food.

The vote of thanks having been passed unanimously,

Dr. Gover, in reply, said the question of temperature was dealt with in the paper. In tropical regions the inhabitants lived chiefly on carbo-hydrates, compounds in which the hydrogen and carbon were in such proportion that water was formed, while the oxidation of those bodies resulted in the elimination of carbonic acid. In the Arctic regions the people lived chiefly on hydrocarbons, in which there was a large quantity of unoxidised carbon, and the oxidation of that carbon and hydrogen going on very actively, kept up the animal heat which was so necessary to their existence. If the inhabitants of tropical lands were to live on hydrocarbons their circulation would be overloaded, their livers would become enlarged, and fatal results would follow. With regard to the cooking of meat, two mistakes were very commonly made, first in not varying the temperature at different stages, and secondly, in employing too high a temperature all through the process, partly in stewing and boiling. He was glad to hear that there was a good supply of water-cresses in London, but it would certainly be well to encourage their consumption, especially amongst the poor, who often did not get a sufficient supply of other vegetables. A great deal was said about the evils of drinking to excess, on which subject Dr. Carpenter had recently delivered a brilliant address before the Medical Society of London; but hardly anyone said anything about over-eating; yet he was quite satisfied that as much evil was caused by that as by over-drinking. Not only was this subject overlooked, but over-eating was positively encouraged by some of the dietaries which were put forward, and he had, therefore, endeavoured to rectify the balance by bringing this point prominently forward. He was doubtful about the desirability of postponing drinking until after eating, and thought there was rather too much theory about it. General experience was entitled to great weight on such a question, and, as a rule, people ate and drank at the same time. He believed there was an enormous difference in the digestive powers of different people; in fact, many persons digested far too well. If it were not so, assimilation would not go on so rapidly, and the fluids and solids would not become overloaded with material which was not required, but a great deal of the superfluous matter would be immediately carried out of the system. Dr. Braddon's remark on the stimulating character of animal food was quite correct, and here he would draw attention to the usefulness of Liebig's extract as a stimulant. It was too frequently used as a nutritive agent, and people thought they made beef tea by dissolving a tea-spoonful of it in hot water. But they did nothing of the kind. They got only the stimulating elements of the meat, and made a solution which might be compared to wine, but which had no nourishment in it. It was too much depended on, especially in the case of persons recovering from fevers, and other states where nutriment was required. He would suggest the desirability of using the extract as an addition to beef tea made in the ordinary way, as by that means they would get the nutriment and stimulant together in a compendious form, which would be very useful. With regard to fruit, he should say that in this country people should be very careful about uncooked fruit. It had been said that the only ripe fruit we ever had were roast apples, and there was something in that. It depended in some degree where the fruit came from, and no absolute rule could be laid down, but, generally speaking, cooked fruit was more desirable than raw.

PATENT-OFFICE.

A notice has just been issued that an open competition for six situations, as index and abridging clerk in the Patent-office, will be held on the 18th June next. The salary is to commence at £250, and will rise by triennial increments of £37 10s. to £400. The examination will comprise the following subjects:—1. Précis; 2. Geometry (Elementary and Practical); 3. Mechanical Drawing; 4. Mechanics and Mechanism: 5. Chemistry; 6. Electricity and Magnetism; 7. Hydrostatics, Hydraulics, Pneumatics. Candidates must pass in either 4 or 5, there being four situations in which a knowledge of mechanics, &c. (4), and two in which a knowledge of chemistry (5) is requisite.

It is understood that the new department thus to be formed in the Patent-office will be placed under the direction of one of the first class clerks of the Patent-office, who will be assisted by another experienced clerk, and that its first duties will consist in preparing a fresh subject matter index to the patent specifications filed under the old Patent Law before 1852, and in amalgamating into one or two volumes the annual indexes, alphabetical and subject matter, which have been issued since that date. It is also presumably intended that this department should hereafter undertake the preparation of abridgments of the specifications. It may be remembered that from 1866 to 1874, patentees were required to send in with their provisional specification an abridgment of the same. These, however, were found so entirely

worthless that it was determined to discontinue them. Abridgments of specifications are also published in classes. Most of the classes have been completed down to 1866, and the continuation of this issue down to 1876 has just been taken in hand. Several volumes of the second series are now nearly ready, and will shortly be published. All the work is now done by qualified persons employed by the office, but not on the permanent staff, under the direction of a small department of the office. It has, however, always been found that this staff in the office has been too small to supervise and check efficiently the whole work, and hence it has proceeded but slowly. The anticipation now is that as soon as the new staff has got into working order, such arrangements may be made as may ensure the regular indexing and abridging of all specifications as received, so that the work may be brought up to date, and the utmost possible facilities given to inventors for ascertaining how far their ideas have been anticipated by their predecessors. Whether any system of examinations of applications be ever introduced or not, there can be no question as to value to intending patentees of a ready and easy means of making sure of the originality of their inventions.

NOTICES.

PROCEEDINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at eight o'clock.

May 22.—"Controlling and Correcting Clocks by Electricity." By Frederick J. Ritchie, Esq. W. Hawes, Esq., Deputy-Chairman of the Council, will preside.

May 29.—"The Late Explorations in Mycenæ, Troy, and Ephesus. By William Simpson, Esq., F.R.G.S. Illustrated by water-colour drawings, taken on the spot.

AFRICAN SECTION.

Tuesday evenings, at Eight o'clock.

May 28.—"A Year on the Nyassa, with Notes on the Slave Trade, and on the Prospects and Means of Opening up the Surrounding Country." By H. B. Cotterill, Esq.

CHEMICAL SECTION.

Thursday evenings at eight o'clock.

May 23.—"The Position of Chemistry in a System of Technical Education, as illustrated by some of its applications." By J. M. Thomson, Esq., F.C.S., of King's College, London. Dr. J. H. Gladstone, F.R.S., will preside.

INDIAN SECTION.

Friday evenings at eight o'clock.

May 17.—"Agriculture in India." By F. C. Danvers, Esq.

CANTOR LECTURES.

Monday Evenings, at Eight o'clock. The Third Course, for the present Session, on "Some Researches on Putrefactive Changes, and their Results in relation to the Preservation of Animal Substances." By B. W. Richardson, Esq., M.D., F.R.S. The Fifth Lecture will be delivered on Monday, May 20; the date for the remaining Lecture will be May 27.

MEETINGS FOR THE ENSUING WEEK.

Mon.... **SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Dr. Benjamin W. Richardson, "Some Researches on Putrefactive Changes, and their Results in Relation to the Preservation of Animal Substances." (Lecture V.)

Society of Engineers, 6, Westminster-chambers. 7½ p.m. Adjourned discussion on Mr. Henry S. Copland's paper, "Modern Roadway Construction."

Royal United Service Institution, Whitehall-yard, S.W., 8½ p.m. Mr. J. L. Haddan, "Military Railways."

British Architects, 9, Conduit-street, W., 8 p.m. Prof. Barff, "The Prevention of Corrosion in Iron."

Asiatic, 22, Albemarle-street, W., 4 p.m. Annual Meeting.

Victoria Institute, 10, Adelphi-terrace, W.C., 8 p.m. Annual Meeting.

Tues.... **SOCIETY OF ARTS**, John-street, Adelphi, W.C., 11 a.m. Conference on Water Supply. Afternoon Sitting, 2 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. T. Thistleton Dyer, "Some Points in Vegetable Morphology." (Lecture IV.)

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. T. C. Clarke, "The Design, generally, of Iron Bridges, of very Large Span, for Railway Traffic."

Statistical, Somerset-house-terrace, Strand, W.C., 7¾ p.m. Mr. William Newmarch, "The Progress of the Foreign Trade of the United Kingdom since 1856, with especial reference to the Effects Produced upon it by the Protectionist Tariffs of other Countries"

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Zoological, 11, Hanover square, W., 8½ p.m. 1. Lieut.-Col. R. H. Beddome, "Description of a New Genus of Snakes, in the Family of *Calamaridæ* from Southern India." 2. Mr. P. L. Sclater, "Reports on the Collection of Birds made during the Voyage of H.M.S. *Challenger*, No. X.—On the Birds of the Atlantic Islands and Kerguelen's Land, and on the Miscellaneous Collections." 3 Mr. J. Wood Mason, "On New and little-known *Mantidæ*."

Royal Horticultural, South Kensington, S.W., 11 a.m.

Wed.... **SOCIETY OF ARTS**, John-street, Adelphi, W.C., 11 a.m. Conference on Water Supply. Afternoon Sitting, 2 p.m. 8 p.m. Mr. Frederick J. Ritchie, "Controlling and Correcting Clocks by Electricity."

Geological, Burlington House, W., 8 p.m. 1. Prof. T. G. Bonny, "The Serpentine and Associated Rocks of the Ayrshire Coast." 2. Dr Henry Hicks, "The Metamorphic and Succeeding Rocks in the neighbourhood of Loch Maree, Rosshire." 3. Dr. A. Wichmann, "A Microscopical Study of some Huronian Clay-slates." 4. Mr. C. P. Sheibner, "Foyate, and Elæolitic Syenite Occurring in Portugal." 5. Mr. W. A. E. Ussher, "The Triassic Rocks of Normandy and their Environments."

Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m. 1. Mr. J. W. Redhouse, "The Turkish Race as a Nationality." 2. Sir Patrick Colquhoun, "The Present Greek Race.

Royal Botanic, Inner Circle, Regent's-park, N.W., 2 p.m. Summer Exhibition.

Thur ... **SOCIETY OF ARTS**, John-street, Adelphi, W.C., 11 a.m. Annual Conference on Health and Sewage of Towns. Afternoon Sitting, 2 p.m. 8 p.m. (Chemical Section.) Mr. J. M. Thomson, "The Position of Chemistry in a System of Technical Education, as Illustrated by Some of its Applications."

Royal, Burlington House, W., 8½ p.m.

Antiquaries, Burlington House, W., 8½ p.m.

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Conversazione.

Royal Institution, Albemarle-street, W., 3 p.m. Lord Rayleigh, "Colour." (Lecture IV.)

Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.

Philosophical Club, Willis's-rooms, St. James's, S.W., 6½ p.m.

Fri....... **SOCIETY OF ARTS**, John-street, Adelphi, W.C., 11 a.m Annual Conference on Health and Sewage of Towns Afternoon Sitting, 2 p.m.

Linnean, Burlington House, W., 3 p.m. Annual Meeting. President's Address. Rear-Admiral R. Vesey Hamilton, "Lessons to be Derived from the American Naval War."

Royal United Service Institution, Whitehall-yard, 3 p.m.

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Prof. Ramsay, "The Geology of Gibraltar and the opposite Coast of Africa."

Quekett Microscopical Club, University College, W.C., 8 p.m. Mr. B. Thompson Lowne, "The Structure of the Eyes of Insects."

Clinical, 53, Berners-street, W., 8½ p.m.

Royal Botanic, Inner Circle, Regent's-park, N.W., 4 p.m. Professor Bentley, "Classification, Properties, and Uses of Plants. Characters of the Three Classes of the Natural System: — 1. Dicotyledones. 2. Monocotyledones. 3. Acotyledones. Characters of the Sub-Classes: —A. Sub-Classes of the Acotyledones—1. Thallogenæ. 2. Acrogenæ. B. Sub-Classes of Monocotyledones." (Lecture III.)

Sat....... Physical, The Science Schools, South Kensington, S.W. 3 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Henry Morley, "Richard Steele." (Lecture IV.)

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,331. VOL. XXVI.

FRIDAY, MAY 24, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

CONVERSAZIONE.

The Society's *Conversazione* is fixed to take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday, the 19th June. The cards of invitation will be issued shortly.

NATIONAL WATER SUPPLY. HEALTH AND SEWAGE OF TOWNS.

The Congress on National Water Supply was held on Tuesday and Wednesday, the 21st and 22nd inst., Sir HENRY COLE, K.C.B. (in the unavoidable absence of Sir Ughtred Kay Shuttleworth, Bart., M.P.), in the chair. The programme of proceedings was as follows:—

Tuesday, 11 a.m.—Opening of the proceedings by the Chairman.

Papers and Discussions on—

1. The Great Natural Water Resources of the Kingdom.
2. How they can best be utilised and economised for the supply of:—
   - *a.* Large Towns, Small Towns, and Country Places.
   - *b.* London.

Wednesday, 11 a.m.—Papers and Discussions continued.

The following abridged report is taken from the *Times*, the fuller report, which will appear hereafter, being kept back to give time for correction :—

A Conference on National Water Supply commenced its sitting on Tuesday at the rooms of the Society of Arts, under the presidency of Sir H. Cole, K.C.B. On the 30th of January last, the President of the Society of Arts, the Prince of Wales, addressed a letter to the Chairman of the Council, suggesting that, as "The supply of pure water to the population is at the present time exciting deep interest throughout the country, great public good would arise from an open discussion of the question in the Society's rooms." The Council appointed a committee to give effect to the wish expressed in the Prince's letter, and their arrangements included the preparation of a pamphlet setting forth what had already been done in inquiries on water supply, the collection of written communications from those competent to give opinions on various aspects of the question as to what remains to be done, and obtaining returns from medical officers of health and sanitary authorities, as to the condition of water supply in various towns and sanitary districts. These were printed and laid before the Conference. The Conference was attended by representatives from different parts of England.

The Chairman, in opening the proceedings, alluded to the state of the water supply of such a large place as Manchester. Its river was so filthy that if a man fell in he might, from its shallowness, escape being drowned, but he would be suffocated by filth. He did not fear any picturesque loss by utilising Thirlmere as a source of supply. Looking broadly at the whole question, he thought that what was wanted was the appointment of a few authorities who could regulate the arrangements of the water supply of large districts. England, for such a purpose, might be divided into a sort of heptarchy. It was important first to know where were the districts of large rainfall whence good water could be obtained, and then to arrange arterial systems of great aqueducts. He thought such arrangement would prove a safer investment for money than many foreign bonds.

Mr. G. J. Symons spoke on the subject of rainfall. He had, with a voluntary staff all over England, collected much valuable information, and he had no doubt the Government would one day take the matter up. The bulk of the supply of rain falls on elevated mountain tracts, in illustration of which he referred to the maps he prepared for the sixth report of the Rivers Pollution Commission. Our population is thin in mountainous districts and thick on the plains, where the rainfall is less, so that a very obvious course is to conduct the water from high regions to low. Englishmen have never taken a proper broad and comprehensive view of the subject, and this he attributed to our line of public education. Our population is doubling every 25 years; we cannot increase our rainfall, we must use it to the best advantage before it is fouled. New arrangements must of necessity arise in the future, and it would be well if all hydraulic works were undertaken or supervised by a Government department, the officers of which should receive a scientific training such as is given at the school of the *Ponts et Chaussées*.

Mr. Lucas drew attention to the underground watersheds, and urged that all water-bearing strata should be surveyed by Government officers. In illustration of the results he anticipated, he exhibited some maps of the London district. For such surveys he, a few years ago, invented the name hydrogeological.

Rev. J. Clutterbuck entered into details to prove that the yield of rivers is much over-estimated, and showed that the rainfall of a district gives but a very imperfect clue to the amount of water available therefrom.

Mr. Edwin Chadwick, C.B., expressed his belief that the geological survey could furnish much information not yet published as to the resources of water-bearing strata.

Mr. Conder referred to the way in which, under a Government Commission, the water supply of Italy had been studied, and he quoted from a "Hydrographic Compendium of the Italian Provinces, with orographic, geographic, and climatological references," and from a "Hydrometric Synopsis of One Hundred Rivers and Torrents of Continental and Insular Italy."

Dr. Child, while recognising the advantage of local government for many purposes, believed the water supply needed the exercise of control over larger areas.

Mr. Shelford, in supporting Mr. Lucas's idea of the importance of hydrogeographical surveys, alluded to cases in his own experience in the Lincolnshire Wolds, where much of the rainfall found its way by subterranean passages into the sea.

Dr. Bond urged that all water supply arrangements should be under a Commission of a permanent kind, unaffected by change of Governments, after the model of the Charity Commission.

Mr. de Rance, of her Majesty's Geological Survey, presented in tabulated form a statement respecting the water-bearing qualities of the different formations of the country. He also mentioned cases in which money had been squandered in obtaining water, through want of

using knowledge already acquired. He showed that no one general scheme for the whole country is possible, as different districts require different plans.

Mr. J. Evans, D.C.L., referred to the loss of much of the rainfall by evaporation and vegetation. On chalk only from 6 in. to 8 in. of rain finds its way more than 3 ft. down. He also discussed some of the arrangements for payment for water in country districts, which he regarded as very unfair to owners of mills and factories.

Mr. Pierce urged that the Government must take the whole matter in hand, as private enterprises are no longer competent to deal with the increasing difficulties.

Dr. Wright, of Cheltenham, pointed out that the rainfall on the Cotswold Hills really helped to supply London, and they needed some artificial arrangements to retain their own natural rainfall.

Mr. Shelford showed some interesting maps of London, tinted to illustrate the increase of population and of rateable property in certain districts. The rateable value on which water rates may be levied is increasing at a greater ratio than the population.

Mr. A. H. P. Brown, M.P., spoke on the Bill he has carried through the House of Commons; and a number of officers of health, in alluding to it, praised it for what it was likely to accomplish, though it was still not all that was wanted.

Many of the subsequent speakers alluded to the financial aspects of the improvement of supplies.

The Conference resumed its sitting on Wednesday, when the supply of London was considered.

The Chairman (Sir H. Cole) suggested it would be well to keep to the strictly scientific consideration of what was wanted and the means by which the want could be supplied, apart from any financial considerations.

Professor Frankland expressed his belief that, of all the river basins of England, none gave a better natural supply than the Thames basin. There is very little upland water in it, and its chief resource, especially in long-continued drought, is the spring supply. He had given up his old objection to a double supply for a town; and he now believed there should be what may be called an "indoor" supply for drinking and domestic purposes of a water of a high standard of purity, uncontaminable from sewage or sewer gas, and supplied on the constant plan, and a separate "outdoor" supply for other ordinary purposes. There is at present much indoor unnecessary waste, and a meter system would check this. The Thames at London-bridge even gave water quite good enough for outdoor use. For fires he thought a special high-pressure service would be of use.

Admiral Sir Erasmus Ommanney, C.B., F.R.S., asked how far the Thames had been improved since the change of control over its upper portions since 1866?

Professor Frankland answered he had no data for a reply.

Mr. Williams, of Liverpool, deprecated the introduction of a meter system to limit a supply.

Mr. Chadwick urged that it was ignorance of the real requirements to suppose that what is called an abundant supply is an advantage. In speaking of the quality of water used, he said careful distinction must be made between water "as supplied" and "as used," as it was in many parts of London deteriorated by the household fittings.

Mr. Towle, of Oxford, saw no reason why the Thames should not come to London unpolluted by any sewage. All the towns on its banks should have sewage farms, and utilise instead of wasting the valuable manure.

Mr. Homersham spoke in favour of a chalk supply softened by Clarke's process. He objected to the meter system. Small private companies, he thought, often arrange a better supply than large public companies, a remark which called forth expressions of dissent.

Mr. Hassard read a paper on a scheme for supplying London from the lake district, which was, however, much the same as that described in the report of the Commissioners.

Mr. Baldwin Latham referred to Mr. Rawlinson's evidence recently given before a Committee of the House of Commons, in which he said he thought the evils attributed to so-called bad water were exaggerated. Mr. Latham read extracts from the evidence of chemists given before different Commissions, which he said was conflicting, and it showed that chemists could not tell what was unhealthy water.

Mr. Mitchell remarked that he believed the duty of analysts was simply to analyse and report on what they found. It was for the medical practitioner to trace what effect certain waters had under certain conditions. He quite agreed, however, that very little was known except with reference to recognised epidemic diseases, and he referred to the hundred and odd replies sent in answering questions circulated by the Council on that subject, which gave the experience of officers of health.

Mr. Vacher, medical officer of Birkenhead, spoke of the difficulties of tracing the connection between ill-health and water rather than air or other surroundings.

Dr. Elliott, of Carlisle, spoke on entozoa as one of the results of bad water.

A long discussion then followed on the use of lead for pipes and fittings.

Mr. Fox, of Cockermouth, drew attention to the fact that the Derwent delivers more water than the Thames, and that there was a good and abundant supply of water in the district, which it would be a positive advantage to the district to have taken elsewhere, and no fear of damage to picturesque effect need be entertained.

A discussion on the purchase of the London companies' works called forth many diverse opinions, warmly advocated, amidst many interruptions and frequent rulings from the chair.

Prof. Prestwich was called on to read his paper. He treated the subject of supply from a geological standpoint.

After discussion on several unconnected points,

Dr. Wright, of Cheltenham, moved the following resolution:—"That this Congress desires to urge upon her Majesty's Government the importance of taking steps, with the least possible delay, to appoint a small permanent Commission, to investigate and collect facts connected with water supply in the various districts throughout the United Kingdom, in order to facilitate the utilisation of the national sources of water supply, for the benefit of the country as a whole, as suggested by his Royal Highness the Prince of Wales, the President of the Society of Arts, and recommends that the Council of the Society of Arts be requested to ask the Earl of Beaconsfield to receive a deputation to present the resolution and advocate its adoption."

This was carried unanimously.

The Prince was thanked by resolution for his letter.

The Conference on Health and Sewage of Towns was held on Thursday and Friday, the 23rd and 24th inst., the Right Hon. James Stansfeld, M.P., in the chair. The programme of proceedings was as follows:—

Thursday, 11 a.m.—Opening of the Proceedings by the Chairman.

Papers and Discussions on—

1st. Gradual Abolition of Cesspools and Middens, and Substitution of Tubs and Pails, with speedy removal.
2nd. Progress, if any, made in Treating Water-carried Sewage since the last Congress.
3rd. Escape of Sewage Gas into Dwellings, and Modes of Prevention.
4th. Progress, if any, made in the Utilisation of Excreta since the last Conference.
5th. Discharge of Sewage into Sea.
6th. Cost of Systems given in the last Report of the Local Government Board.

Friday, 11 a.m.

7th. Whether any further Legislation, of a Compulsory or Permissive Character, is needed for bringing about a better Sanitary Conditions of Towns or Dwellings, or any Change in Imperial Administration.

Full reports of the Papers read, and the Discussions taken, will appear in an early number of the *Journal*. They will also be published in pamphlet form, price 2s. 6d.

By direction of the Committee on National Water Supply the various Parliamentary Blue-books referring to the subject have been examined, and a selection made of passages bearing on the points suggested in the letter of H.R.H. the Prince of Wales, by which the question of Water Supply was first brought to the notice of the Council. These extracts (many of which are from books now out of print) will be published shortly, in pamphlet form, price 2s. 6d.

INDIAN SECTION.

Friday, May 17th; James Caird, C.B., in the chair.

The paper read was—

AGRICULTURE IN INDIA.

By F. C. Danvers.

One of the most important questions of the day with regard to the administration of India is, undoubtedly, that of the proper means to be adopted to meet the necessities of the populations in seasons of famine, which are ever recurring in different parts of the Empire, and apparently increasing in intensity and in the extent of their influences. The causes of these famines have engaged the serious consideration of many learned men and scientific societies, and not long since there appears to have been a general concensus of opinion that they were in some way or another attributable to, or at any rate coincident with, certain solar phenomena, which exerted their powers for evil at periods of maximum sun-spots. Whether or not there is any connection between the two, appears, however, upon closer investigation, to admit of considerable doubt; but if the sun-spot theory has any basis of foundation it seems quite clear that human agency must be unavailing to contend with influences operating from a distance so far beyond its reach, and all that can consequently be done will be to provide the means to counteract those influences, so far as may be possible. Valuable as these investigations undoubtedly are from a scientific point of view, it is more desirable that practical men should turn their attention to the discovery of some remedy for famines, rather than to speculations as to their remote and unassailable causes, lest by directing too much attention to extra-terrestrial things, men's minds be diverted into spheres of visionary flight, and away from a consideration of those influences wrought by human agency upon the earth, through alterations in the normal conditions of its surface. This, too, is done without due appreciation of the disturbance thereby created in the equilibrium of natural forces, which undoubtedly constitute the evils whose results are felt during famines, and which it should be the principal aim of science to amend or counteract.

Various remedies have been from time to time proposed, with the view of counteracting the effects of drought in tropical climates, the two most generally advocated being irrigation and improved means of communication. No doubt both of these are most important, as the former class of work, where practicable, provides the means of conveying that moisture to the soil which the rainfall is usually expected to provide, and so rendering cultivation possible where otherwise it could not be undertaken at all; whilst the latter provides the best means for conveying food to famine-stricken districts from seaports, or inland regions, where the necessary supplies may be available for the purpose.

Amongst the various reasons that have been assigned for the occurrence of famines in seasons of drought in India, not the least important appears to be the defective state of agriculture practised by the native cultivators. Although the primary cause in each case of serious famine in India has been either the total failure of the usual rains, their deficiency in quantity, or the inequality of their distribution over the usual seasons of agricultural operations, there seem to be good grounds for believing that, even under the worst conditions of deficient rainfall, the effects of drought upon the soil might be considerably mitigated by a due observance of those laws which are now tolerably well understood in this country, but, either on account of the poverty, or want of energy, of native agriculturists, are more or less neglected in India. Whilst a neglect of the known laws of agriculture would be attended by comparatively unimportant results in this country, where so small a proportion of the population is dependent upon the produce of the land for a living, and by far the greatest part of vegetable and animal food consumed is imported from abroad, the case is quite different in a country like India, which is dependent upon its own internal resources for food supplies, and where considerably more than half the population live by agriculture.

The increasing population of India is constantly necessitating fresh lands being brought under cultivation, in order to meet the ever-growing demands for food; and at the same time the remark appears pretty general that the land is not so productive as it used to be. This, no doubt, has arisen from two causes; in the first place, the land that is now being added to the cultivated area is of an inferior quality, and, under the existing rude state of cultivation the produce which it

yields is often barely sufficient to do more than cover the cost incurred; and, secondly, the exhausting nature of the tillage is gradually lessening the productive powers of the better soils. The state of the country generally appears to be very similar to that of Rome in the first century of the present era, when L. Junius M. Columella, in a letter to Publius Silvinus, stated:—

"The magnates of the State are in the habit of complaining of the sterility of the land, or of the unsettled state of the weather, which has now for a long time exerted an unfavourable influence on the growth of agricultural produce; others are of opinion that the soil has been exhausted by the over-productiveness of former years. But," he continued, "no one gifted with common sense will ever permit himself to be persuaded that our earth has grown old as man grows old. The sterility of our fields is to be imputed to our own doings."

This state of things has, however, not been confined to Rome, for the same results have been observed in modern times in the United States. Mr. H. C. Carey, of Philadelphia, in letters to the President on the foreign and domestic policy of the Union, and the effects as exhibited in the condition of the people and the State, observes, with reference to the practice of annually exhausting the plant food from the fields by constant cropping, without making any corresponding compensation to them in the shape of manure:—

"That the consequences of this may be seen in the fact that the soil is almost everywhere exhausted, and that the prosperity of the country is declining instead of increasing. In New York, where the average yield of wheat was from 25 to 30 bushels eighty years ago, it is now only 12 bushels. In Virginia and Kentucky tobacco was grown until the soil was completely exhausted, and had to be abandoned; and in the cotton districts we met with a state of exhaustion unexampled in the world for the shortness of the time in which it has been brought about."

Evidences of a similar state of things exist with regard to certain parts of India. Mr. Harman, of the Bangalore Government Farm, remarks on the deterioration of the soil in Mysore, owing to the defective agriculture, as shown by a gradual decrease in the out-turn during seven years. In 1868 the average out-turn per acre was, of paddy, 1,577 lbs.; of wheat, 758 lbs.; and of cotton, 676 lbs; in 1874 these quantities were reduced to, paddy, 1,011 lbs.; wheat, 628 lbs.; and cotton, 284½ lbs. Both of these years, it should be stated, were favoured by good seasons. In the Settlement Report of the Hoshungabad district it is stated that the old rate of produce in the Nerbudda Valley fifty years ago is supposed to have been tenfold, but that it is now estimated at only six-fold. Dr. Liebig, in his letters on Modern Agriculture, pp. 176-77, remarks:—

"There are fields that will yield without manuring for 6, 12, 50, or 100 years successfully, crops of cereals, potatoes, vetches, clover, or any other plants, and the whole produce can be carried away from the land; but the inevitable result is at last the same; the soil loses its fertility, the fields will ultimately be brought to a state of exhaustion; the corn will only yield an amount equal to the original seed; the potatoes will no longer produce tubers, and the vetches or clover will die away after barely appearing above the ground."

This appears to be the state of things to which a great part of India is gradually but surely approaching, owing to the defective system of cultivation generally practised by the Ryots. In the settlement report of the Chanda District we read:—

"When fresh soil is broken up for rice cultivation, the ground can never be got into proper order during the first year, and the yield is less than in the old fields. In the second year the return rises about an eighth above that of the old fields, and increases gradually year by year, until the fifth, when it reaches 50 per cent. above the yield of the old fields; it then commences to decline, and in about another five years has subsided to the level of the old fields. Land growing dry crops seems also to reach its highest point of fertility in the fifth year of cultivation, but it falls more slowly to the old fields than is the case with rice lands, and a field twenty years old will be more productive than one which has been fifty years under the plough. When a cultivator sees a field becoming sterile, he allows it to be fallow for from two to five years, in the meanwhile pasturing his cattle thereon, and when the land is again sown, it is found to give a yield equal to its neighbours."

The question as to what measures should be adopted to counteract these evils, is one which affects the State as well as the people themselves. The land being the principal source of revenue to the State, the more produce it can be made to yield the more easily will the land-tax be paid by the people. If the land is only half tilled, and starved as regards manure, the State's share of the produce will appear large, but let the land be properly tilled, and that share will at once bear but a small proportion to the whole produce. As long as only moderately good soils are tilled, a rude system of husbandry may suffice to meet the wants of cultivators, but now that the inferior soils are being taken up for culture, it is necessary that an improved method of agriculture should be adopted. With the exception of irrigated lands, but little manure is generally employed in India, the principal food crops being, as a rule, neither manured nor irrigated. The cultivators are fully aware of the advantages resulting from the use of manure, but as yet they consider that the additional labour and cost involved are not sufficiently compensated by the increased yield. Much of what ought to be given to the fields as manure is now used as fuel, and during the late famine in Southern India some quantities of cattle dung were exported from the district of Trichinopoly to Ceylon, where it fetched a very high price.

With regard to the value of manure in increasing the yield of crops, experiments made by Messrs. Lawes and Gilbert, at Rothamsted, on wheat and barley grown for many successive years on the same ground, may be quoted. The soil experimented on was a rather heavy loam, with a subsoil of raw yellowish-red clay, underlaid with chalk, which provides good natural drainage. The table on the following page shows the difference in the yield on manured and unmanured land; and the figures show a gradual tendency towards exhaustion of the unmanured land, whilst the yield of the manured land was not only more than double that of the unmanured land, and its amount had a tendency to increase instead of diminish, but the weight of grain per bushel was higher from the manured than from the unmanured land.

	Bushels per Acre.				Weight of Bushels per lb.			
	1852-62 yearly average.	1863-72 yearly average.	1873.	1874.	1852-62 yearly average.	1863-72 yearly average.	1873.	1874.
Unmanured land..........	15·3	13·3	11·8	11·5	55·9	59·3	57·0	
Land receiving yearly 14 tons of farm-yard manure per acre.	34·5	36·0	26·8	39·25	59·0	61·0	57·1	60·25

The average produce per acre on a series of observations extending over ten years, in several districts of the Bombay Presidency, was found to be as follows:—

	Bushels		Pounds.
Wheat	9	....	585
Jowari	10	....	650
Bajri......................	6	....	390

So that it appears that, whilst wheat on properly cultivated but unmanured land in England produced a yield of 655 lbs. per acre, in Bombay it yields only 585 lbs., or nearly 11 per cent. less, which difference may possibly be due to inferior cultivation or greater exhaustion of the soil on which the crops were grown, or, in a measure, to both of these causes combined. In the Dehra Dun, the produce from wheat cultivation averages 1,260 lbs. per acre; and at the Sind Experimental Farm, bajri has yielded as much as 1,420 lbs. per acre. Agricultural statistics of this sort are, however, very scarce in India; and it would, perhaps, be hardly fair to take the yield obtained from small areas at Government experimental farms as a proof of what might be realised generally by improved cultivation. What evidence there is on this point, however, shows conclusively that, by proper tillage, the land may be made to yield a better increase than at present, and it has been remarked that, by careful cultivation, the inferior lands, paying a low rate of assessment, do often yield more than the better and more highly assessed lands when badly farmed. There is, indeed, no apparent reason why the soil of India should not, under favourable circumstances of agriculture, yield as much per acre as is obtained in England or any other country.

The value of manure to the soil is not always limited to the supply of plant food. In the case of mineral manures this is no doubt the principal benefit conferred, but with manures containing organic matter it is very different. From experiments made at the Sydapet Government Farm, with soils in their natural condition, and when mixed with 20 per cent. of organic, and 20 per cent. of mineral manure, it appears that the ashes of dung or of any other substance have little or no effect in increasing the moisture condensing powers of a soil, whilst the addition of 25 per cent. of organic matter increased its condensing powers nearly 300 per cent., and to a less degree by the addition of organic manure in smaller proportions. Further experiments showed that, in soils to which 5 per cent. of organic matter had been added, water applied from below moved much more slowly upwards than in the natural soil, and that they held much more water than the unmanured soils, their powers to take up moisture being increased 10 per cent. As a general rule, native farming exhausts the organic matter in the soil, and thus renders it less able to take up moisture from the air, and consequently less able to withstand the effects of a drought. From the foregoing, it appears that not only is organic manure beneficial for increasing the productiveness of a soil by supplying plant food, but it is also calculated to benefit the crops in dry seasons, owing to the effect it has upon the soil of increasing its powers of absorbing moisture from the atmosphere, and of resisting the powers of evaporation. Salt is also a valuable agent in bringing about the same results, for, in the first place, it prevents the too rapid decomposition of organic matter in the soil, and, by the well-known affinity all alkalies have for moisture, it also increases the power of the soil to absorb it from the air.

It is to be feared that, owing to the rapid clearing of the jungles in many parts of India, and the consequent increasing scarcity of firewood, cattle dung is becoming even more extensively used than formerly for fuel, and the land is thus deprived of its natural manure. Under these circumstances, the only alternative appears to be the use of green manure, or of allowing the land to lie fallow periodically. The practice of fallowing, or resting the land, is a practical protest against the waste of continuous clean culture; the growth of grass and weeds shades and protects the surface, appropriates the ammonia of the atmosphere when ploughed under for a crop, and restores to the soil its supply of vegetable matter, wasted under the direct rays of a burning sun. The following advantages of green manuring are instanced in the report of the Department of Agriculture at Washington for 1874:—

1. Economy in transportation and in the application of manures.

2. The rapidity of their decomposition.

3. The saving of all the constitutents of the manure.

4. The elevation of the temperature of the soil in the process of decomposition.

5. The protection of the soil from the effect of solar heat, preventing the evaporation of moisture, and retaining in the soil the fertilising gases derived from the atmosphere, which decompose the vegetable matter in and upon the soil.

6. The pulverisation of the soil, making it loose and friable, by the chemical changes at work in the process of the fermentation of vegetable matter.

This last is by no means the least important result, for soils in a fine state will hold more water than those whose particles are coarse, on account of the greater number of their capillary tubes.

Want of manure is however, not the only cause of the comparative unproductiveness of the soil in India, as in many parts it is rendered sterile owing to the presence of salts in undue proportions. It has been stated by Mr. Robertson, the Superintendent of the Sydapet Government Farm, that a

soil which contains more than a half per cent. of salts capable of being washed out by water cannot possibly be productive, even though it may be rich in the elements of plant food, and that an excess of soluble salt, even of one that may possess considerable value as a manurial agent, will cause barrenness instead of fertility. From an agricultural survey made in Kattywar by Mr. E. C. Schrottky, in which an examination of sterile soils was made, it appears that certain fields which yielded barely sufficient to pay for labour and taxes, contained quantities of chloride of sodium, diminishing from the surface downwards, in the following proportion:—

	Per cent.
First 6 inches of surface soil	3·00
Soil 1 foot below surface..............	0·48
Subsoil 2½ feet	0·44

He considers it evident that the salt, which must have been at one time equally distributed, has been drawn up to the surface by evaporation and capillary attraction. The remedy suggested for this is subsoil drainage, by means of which the salt may be driven down through the upper strata to the lower, instead of the reverse action which now takes place.

Apart from its employment as a means of ridding barren soil of its excess of salt, it may reasonably be supposed that the benefits of subsoil drainage generally would be as great in India as in England. On this point we are not without proof, the system having been tried, with considerable economic results, on the Sydapet Farm, near Madras. The experiments there carried out showed a profit of Rs. 12 in a stone-drained plot, and of nearly Rs. 23 per acre in a pipe-drained plot. Referring to these experiments Mr. Robertson remarks:—

"Satisfactory as are the results, they do not fully exhibit the benefits in this instance gained by subsoil drainage, for it must be remembered that, before draining, the land was hopelessly unproductive, having been rendered so by swamp cultivation."

And, he adds:—

"Throughout the long drought which was experienced during the year, the cotton plant on the pipe-drained land was always green and fresh, while that growing on undrained land was withered and blighted."

The reasons for this appear to be that when land is not drained, heat or cold does not affect the soil deeper than about a foot; but if there be drains underneath, the soil becomes more porous, and permits a greater movement of air. Heat or cold then affects, more or less, the soil between the surface and the drains, a depth of three or four feet. Thus what the heat gains in space it loses in intensity; and the surface soil being, therefore, less heated and baked, loses less moisture by evaporation.

This principle is dwelt upon by Professor Liebig, who states that when in a hot summer the surface of the ground is dried, the powerful attraction of the soil for the vapours of water in the air provides the means of supporting vegetation. A second source from which the dry soil derives by absorption its moisture, is presented by the deeper lying moist strata, from which a constant distillation of water is taking place towards the surface. By drainage, the water, which rises by capillary attraction, being placed at a greater depth, the dry soil now derives from the lower strata a quantity of moisture in the form of vapour which supplies the wants of plants. Hence it appears that subsoil drainage renders the land less liable to be seriously affected by drought, and so far it is calculated, under certain conditions, to mitigate the effects which, in India, now invariably follow upon a failure of the usual rains, or even their unequal distribution during the monsoon seasons. A similar application of drainage to pasture lands would also, doubtless, tend much to improve the quality of the feed for cattle in India, as it has also done in this country, by preventing the herbage from so rapidly drying up, as it does now, during the hot seasons, and by improving the quality of the pasture itself.

One of the great defects in the present system of agriculture in India, has been attributed—and apparently with some reason—to the inefficient manner in which the farm-cattle are fed. As a general rule, the cows are half-starved, and, consequently, but little milk is obtained. The cows and calves, according to the account given in the Hoshungabad Settlement report, get nothing at all except what they can pick up; but sometimes a little food is given them at night for the three months before the rains begin. The bullocks are stall-fed for about three and a half months, from April to the middle of July; thence to the end of October they live on the grass they find, and after that, to the end of January, that resource has to be supplemented by a gradually increasing quantity of hay, and during February and March they live on the green teora, wheat stubble, and the threshing floor. A cultivator, with 25 acres of arable land to each plough, requires eight acres of pasture to support his cattle; but besides the fallows, there exists, in some districts, in the hill pasturages, a resource which is largely utilised, and no doubt might be often more extensively made use than it now is.

In India grasses for food for cattle do not appear to be ever cultivated. The ryot never manures his pasture land, and he crops it incessantly with cattle, sheep, and goats, as long as these animals can obtain a scanty support on it. The only time when the pasture land is allowed rest is during and after heavy rain, when the grass which then springs up is considered to be noxious to live stock. The grasses are thus never permitted to produce seed, or only to a very limited extent, and hence much of the ground remains bare. Under these circumstances, it can be no cause of wonder that the cattle are small and poor; and there is an opinion, in some parts at least, that they are inferior to what they were some years back. One effect of this is that the cattle, being deficient in strength, are unable to draw heavy ploughs so as to admit of the ground being properly cultivated. On unirrigated land the soil is everywhere only shallow-ploughed, and the plough mostly used only stirs the soil but does not turn it over. Mr. Robertson, in a recent report on the Coimbatore District, remarked upon the defective style of ploughing. In one or two places he saw some good cultivation which had been produced by digging the ground over with crowbars, by means of which the soil had been stirred to a depth of fully 12 inches. Blocks of soil, varying in weight from 10 lbs. to 12 lbs. are, by this means, raised and turned over during the dry

weather; after a heavy shower of rain these fall to pieces and a fine tilth is produced. The effects of this crow-bar cultivation are supposed to last over 10 to 12 years. This system of tillage is, however, slow, tedious, and expensive, but the same results might be obtained by the use of improved ploughs and agricultural implements at a less cost—after the first outlay—than is now incurred for the miserable system in general use. The native plough, of which specimens are shown in this room, is very much the same over the greater part of India. It varies in weight from about 40 lbs. to 80 lbs. or even 100 lbs. The iron share weighs from 1 lb. to 6 lbs. In ploughing, the ground is scratched over several times—sometimes of often as five or six times—after which comes the sowing. The preliminary ploughings disturb the surface, but do not turn the soil over, to a depth of about four inches, and the drill plough goes about three inches deeper. The upper four inches of soil are well dried in the process of ploughing, but the drill plough lets the seed down into a lower and moist stratum.

The illustrations exhibited on the wall, which have been kindly furnished by Messrs. Ransomes, Sims, and Head, of Ipswich, for the purpose of the present paper, represent five classes of plough suitable for Indian agriculture, most of which are actually at work in that country.

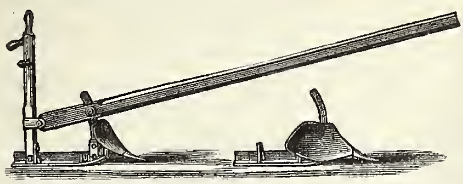


FIG. 1.

No. 1 represents an adaptation of an Egyptian plough, which turns a furrow 8 inches wide by 5 inches deep. It weighs 89 lbs. The small breast attached to the plough is intended for breaking up land, whilst the larger one, which is shown detached in the drawing, is intended to be used when the land is well cultivated and broken up.

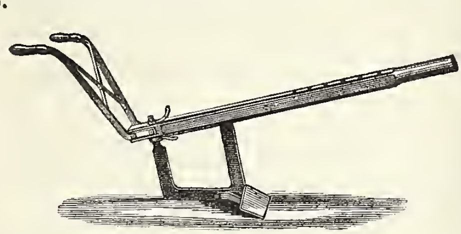


FIG. 2.

No. 2 represents a small wooden plough, for turning a furrow about 7 inches deep and 10 inches wide. Its weight is 51 lbs. This is thoroughly adapted for ploughing in all wheat-growing districts, and can be used with a couple of strong oxen on medium and light soils.

No 3 represents a light plough, made entirely of iron and steel, capable of turning a furrow 4 inches deep and 8 inches wide, with a pair of small bullocks. This plough is called a "turn-wrest plough," that is to say, the breast is made double, so that when the ploughman arrives at the end of the furrow, and has thrown the soil on the right-

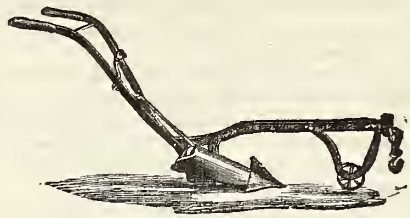


FIG. 3.

hand side, he changes the position of the breast, so that the plough will throw the soil on the left-hand side of the breast when returning. It weighs 63 lbs.

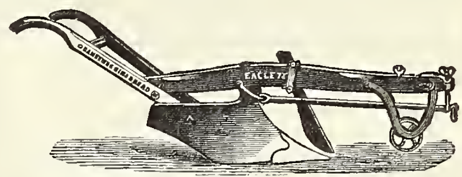


FIG. 4.

No. 4 is a common subsoil plough, as used in Bohemia, and some parts of Austria. This subsoiler is intended to follow an ordinary plough, and will pulverise the soil to a depth of about 12 to 13 inches. Its weight is about 105 lbs.

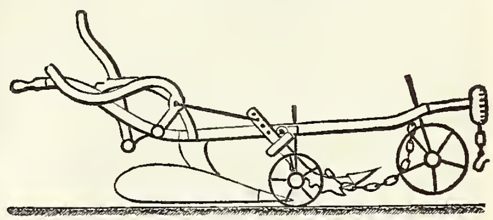


FIG. 5.

Nos. 5 and 6 show an improved subsoiler, which can be used as a double-furrow plough, or as a combined plough and subsoiler, as shown in the drawing, by

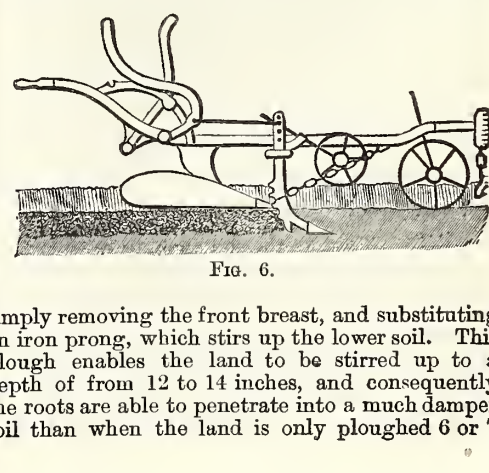


FIG. 6.

simply removing the front breast, and substituting an iron prong, which stirs up the lower soil. This plough enables the land to be stirred up to a depth of from 12 to 14 inches, and consequently the roots are able to penetrate into a much damper soil than when the land is only ploughed 6 or 7

inches. It is, however, heavy, and weighs 4 cwt. 1 qr.

The benefits to be derived from stirring up the subsoil will be appreciated wherever the upper soil has become considerably impoverished by continued over-cropping.

The results of experiments made on the Wisconsin University Farm during the years 1871-74, in testing the effects of different depths of ploughing on nearly level clay land, having a stiff clay snbsoil, may, perhaps, not inappropriately be referred to. It was shown by these experiments that deep ploughing was the more advantageous in very dry seasons; but in other years shallow ploughing was preferred, owing to the want of drainage, and of outlet for the superfluous water which flowed on the retentive soil. These defects were remedied in the fall of 1873, by laying an underground drain through each of the plots.

The following table includes the results obtained in 1874, which was a dry season. The yield is given in bushels of 75 lbs. each:—

Method of cultivation.	1871.	1872.	1873.	1874.
	bushels.	bushels.	bushels	bushels.
Ploughed, 5 inches deep ..	55·4	43·5	53·4	53·0
Do. 12 do. ..	50·6	50·3	52·8	58·1
French ploughed, 18 do...	44·9	54·7	53·1	65·3
Subsoiled, 18 do. ..	52·2	56·8	51·1	60·8

In a report by Dr. Lynch, of trials made with English and American ploughs, at the Presidency Jail Garden, at Calcutta, it is stated that both English and American ploughs were easily worked by a pair of ordinary bullocks. As regards the quality of the work, it was found that a native ploughman, using the English plough, was capable of turning up the soil to a depth of six inches more rapidly than he could turn over the same extent of ground to a depth of three inches with a native plough. Apart from the advantage of mere ploughing, however, the English plough was found to possess other powers, such as hoeing, ridging, and furrowing, all of which could be done far more cheaply and rapidly therewith than by native implements.

At the Model Farm, at Allahabad, the English plough, worked by buffaloes, was held to produce far better ground in less time than the native ploughs; whilst Mr. Lloyd, the superintendent of the Amritsar Farm, has stated that the out-turn from land worked with the English plough is certainly not less than 15 or 20 per cent. more than that worked entirely on the native system.

Deep ploughing, by opening up the soil, will, as has been already explained, enable the land to retain moisture longer than when cultivated under the native system. In some cases of barrenness, it may be shown that deep ploughing alone is necessary to restore the soil again to fertility; for, as is pointed out in a recent report on the Sydapet Farm, if the surface soil to a depth of three or four inches, contains say, one per cent. of soluble salts, that would, of course, render the soil unproductive if only tilled to that depth; but if analysis proved that the strata immediately beneath contained say, only ¼ per cent. of soluble salts, it is easy to see that to improve the surface soil it would only be necessary to plough deeply into the lower soil, and mix it with the upper layer. But, whilst dilating upon the advantages generally derived from deep ploughing, it must be borne in mind that occasionally the results are otherwise than beneficial. Dr. Voelcker has published an account of a case in Holland in which, after deep ploughing, the land refused to grow anything, even weeds. The work was undertaken by an English gentleman near Haarlem, and the result was discouraging and disastrous owing, to the presence of protosalts of sulphur, sulphites and sulphides, in the deeper layers of the soil. These poisoned the surface soil, and required years before they became sufficiently oxidised to be harmless or beneficial. Mr. John Wrighton, of the Agricultural College, Cirencester, in a letter to myself on this subject, remarks as follows:—

"1. The bringing up to the surface of partially decomposed (sour) substances of acid reaction would always be injurious, and could only be done successfully, if at all, by gradual deepening of the soil undertaken during successive seasons.

"2. Deep ploughing should not be attempted where the subsoil is of inferior quality. In this neighbourhood, when the upper chalk is close to the surface, we never allow the white crust to be ploughed up. It would swamp the thin layer of good soil on the surface, and if done rashly would spoil the field.

"3. It was generally thought that much mischief was done on some of the fields of the Royal Agricultural College at Cirencester (great oolite formation) by too deep ploughing.

"4. To rashly plough up clay lands much deeper than previously would also introduce an intractable element. Such newly brought up matter would not pulverise for a long time, and would do harm. It was the late Mr. W. Smith's (of Deanstown) idea, to first shiver and break such soils with the subsoil plough without bringing the material to the surface, and afterwards to deep plough when air and water had acted upon the subsoil. Also good farmers of clay land will gradually deepen these soils by ploughing just a little deeper before taking roots, that is about every four years. The deeper furrow is given in the autumn so as to receive the benefits of the frosts in winter.

"5. Deep ploughing is not usually thought advisable for corn in this country. The late Mr. Smith, of Lois Weedon, certainly dug deeply for wheat, but his extra depth was obtained by going a little deeper every year. On clay lands a fairly deep furrow for wheat is given consistently with paragraph 4 of this letter, but barley is generally thought to prefer a shallow furrow and a fine surface.

"6. Ploughing for 'roots,' *i.e.*, mangel, swedes, carrots, turnips, &c., is the opportunity for giving a deep furrow, usually taken by good farmers in England, and even then care is taken to bring only a small amount of fresh soil to the surface.

"7. Deep ploughing is sometimes advisable, as upon deep alluvial soils, where the texture and quality of the soil is uniform to a considerable depth. But even here the case first cited should be borne in mind. From all I hear and read there is no doubt better and deeper cultivation might be introduced successfully in India."

It is impossible to omit, in this paper, some reference to the subject of irrigation, which has been so strongly advocated as a panacea for famines. All water is, however, not equally beneficial for the purposes of irrigation. When carbonic acid gas is carried into the soil by irrigation water, it acts upon and sets free large quantities of previously inert plant food, and in this way contri-

butes to the production of a good crop, but Mr. Robertson, in a recent report, has observed that there is a wide difference between the action of an irrigation water containing potash, and that of one containing only carbonic acid; the former supplies directly the material which aids in the production of the crop, the latter merely stimulates into activity the plant food previously in the soil; hence, a piece of land irrigated by the former water may be maintained in a fertile state for years, while land, irrigated by the latter, becomes gradually poorer as each successive crop is removed.

The quantity of water really required, or that is most beneficial to a crop, is a question that does not appear to have been sufficiently considered, but experiments in this direction have been made at the Lucknow Horticultural Garden. Here four beegahs of land were each divided into four equal parts, each for a crop of wheat, gram, barley, and peas. One-fourth beegah was irrigated every seventh day, one-fourth every fourteenth, one-fourth every twenty-eighth day, and one-fourth was unirrigated. The difference in irrigation did not appear to affect the quality of the grain, but the quantity of the produce was affected in a very marked manner. The most satisfactory produce was that by one irrigation every twenty-eight days. In all cases the amount of grain by irrigation once in twenty-eight days was nearly double, or more than double that by irrigation once every week. The amount of straw in the case of wheat and gram was also increased by diminishing the number of irrigations, but not to such a marked extent as the grain. In certain observations made in the Godavari District, in 1872, it was noticed that for rice cultivation the ryot took water to the aggregate extent of 9 feet deep, in addition to a rainfall of 26 inches to bring to maturity one acre of paddy. The quantity used in other irrigation experiments varied from 6 to 7 feet in depth in addition to the rainfall. Mr. Robertson, of Madras Farm, however, asserts that under moderately good cultivation, with a soil of fair average quality, a volume of water about 4 feet in depth would be ample for the production of a paddy crop; "not only," he observes, "does swamp irrigation cause an enormous waste of a valuable producing power, but it is highly prejudicial in many other ways; the health of the people is injured; the soil is rendered unfit for cultivation, except under semi-aquatic crops of low types, and the capabilities of our irrigation works are lessened by the smaller area thus watered." These are most important facts, affecting not only the value of irrigation to the cultivator, but it necessarily follows, that if irrigation water is used so largely in excess of what is necessary, a more judicious distribution of it would enable existing irrigation works to command considerably increased areas of cultivation, and the question as to the remunerativeness of that class of works would be at once set at rest.

The last question, which it is proposed briefly to consider, in the present paper, is the influence of trees as affecting climate and cultivation. It is a well-known fact, that the wholesale destruction of trees is not conducive to the improvement of the agricultural prospects of any country, but quite the contrary; and the injurious effects of destroying the balance of nature between tree covered and open lands have been too repeatedly experienced to admit of any question. In a letter addressed to Sir Joseph Hooker, by the Superintendent of Gardens in Jamaica, of the 5th November last, it is stated that, in certain localities hundreds of thousands of acres have been converted into desert by the wholesale destruction of forests, and that in other localities hundreds of thousands of acres would, from the same cause, now be utterly unproductive but for the interposition of foreign trees. Mr. Buck, Director of Agriculture in the North-Western Provinces, has observed:—

"It may be admitted as an axiom that trees are a powerful engine in the production of coolness and moisture, and that their growth throughout a country afflicted with dryness and heat should be promoted. The protection of mountain forests is all very well as far as it goes, but a much greater, because a more proximate influence will be exercised by the increase and encouragement of scattered groves, of lines of trees, and of small plantations throughout the agricultural area of the provinces, in which direction little has yet been done."

This subject was considered in a recent number of the "Indian Agriculturist," wherein it was stated that,—

"The beneficial influence of plantations as shelter to farm lands and crops is apparent and indisputable. Without shelter good crops will not be attained at high elevations, even on moderate soils; and it has been known in cases where land without shelter was not worth cultivation, when portions of it were planted the remainder became good pasture, and yielded a fair return on the cost of labour in cropping it."

The Indian Government is undertaking a work of gigantic magnitude in the conservation of forests throughout the Empire, and the establishment of firewood reserves; but it would evidently be impossible for any staff of officers that could reasonably be employed by Government to undertake or supervise such planting throughout the country as is required in the interests of agriculture generally. A similar want of trees about cultivated lands to that now experienced in India has been felt in different parts of the American continent, and measures have been from time to time adopted with a view to its correction. By a law of California, dated the 30th March, 1868, the Board of Supervisors in each country are empowered to authorise owners of lands to plant and cultivate, along the public highways, shade and fruit trees, specifying the species to be planted, at what age, at what distance from each other and from the road bed, and making the necessary rules for their protection. &c. Four years after the planting, upon receiving a duly certified statement of the number then in a good condition, the Board are directed to pay to the cultivator one dollar for each such tree. The States of Illinois, Missouri, and Iowa have also encouraged tree-planting by State laws. Massachusetts, in 1858, offered a premium of 1,000 dols. for the best plantation of forest trees planted in 1860, payable in 1870. It was won by Major B. P. Poore. States, societies, and individuals have encouraged, by bounties, the planting of trees, with sufficient success at least to excite thought and stimulate effort upon the subject of practical arboriculture. A law of the United States has also recently been enacted for

the encouragement of timber growing. What has been done by other Governments in this direction, might, no doubt, be advantageously followed in India, where, with some such direct pecuniary encouragement as is given in California, there would, it might be anticipated, be no difficulty in vastly extending the areas of plantations throughout the country by voluntary labour, thus securing to agriculture such benefits as accrue from the presence of trees, amongst which may be specially noticed—so far as has been proved by past experience—increased coolness and moisture of atmosphere; protection of crops from storms and winds; improvement of the soil by the decaying vegetation of dead leaves; increased supply of branch wood available for burning as manure; and lastly, but by no means of least importance, additional supplies of firewood, the existence of which would enable the dung of cattle to be more generally devoted to its legitimate use as manure than it is at present.

Having briefly reviewed the various points with respect to which improvements are required in Indian agriculture, and having examined the advantages likely to arise from such improvements—not merely of increased crops, which must necessarily follow upon the introduction of a more intellectual method of cultivation, but of greater security to the crops during exceptional seasons, by enabling the land the better to retain moisture, and so to maintain the life and growth of crops during drought—the question remaining for consideration is—How far, and in what manner, may the experiences of this country be best introduced to the notice of native cultivators with the view to the adoption of improved methods of cultivation by them? The attempt has been made by Government, but it has practically ended in failure. By the establishment of Government farms in different parts of the Empire, presided over by experienced agriculturists, and in which the best known methods of cultivation were adopted, and so practically brought before the notice of farmers, it was hoped that the latter might be induced to adopt the improvements exhibited on these farms. The view had in establishing these farms was three-fold: (1) the introduction of scientific cultivation; (2) the teaching improved agricultural processes for economising labour; and (3) the introduction of new staple products into the country. Referring to these farms, it is observed in the Bengal Administration Report for 1872-73:—

"The fact remains that in practical husbandry the native agriculturists must and will beat us, until we have as exact a knowledge as themselves, of the soil, climate, and plants of the country. This," it is stated, "can only be obtained by careful and protracted observation of their modes of farming by educated European farmers, who, instead of interfering too much with the natives, will be content to watch, season after season, every one of their processes, and the way in which they encounter the emergencies of Indian agriculture. Not until we have done all this, and have become thoroughly familiar with the character and resources of native husbandry, can we hope to set up a model farm amongst them that will not bring discredit upon us by failure."

Excepting as regards the introduction of new staple products into India, these Government farms have hitherto done little towards accomplishing the objects with which they were started, and many of them have consequently been closed. In view of the opinions just quoted, of a late Lieutenant-Governor of Bengal, it does not seem probable that Government farms will ever be likely to accomplish the desired object. Carried on, as they necessarily are, under an expensive supervising staff, the one great element of persuasion, viz., financial success, is wanting, and it can hardly be expected that natives will be encouraged to change their present methods of cultivation, except for one which it is proved to them by demonstration, will give suitable returns for the additional labour and outlay that would probably be required in order to adopt improved systems. It seems to the author that the best means of bringing practically before cultivators the advantages of western improvements in land culture would be through the agency of agri-horticultural societies, to whom special privileges and assistance might be given by Government in carrying out such measures as might be deemed best adapted to secure the great end in view.

In conclusion, it may be pointed out that, besides the benefits that would accrue to India herself from the introduction of improved methods of cultivation, by increasing her food supplies available for export and for home use, and by rendering the crops more secure against failure in unpropitious seasons, this country also has most positive interests, direct and indirect, in the successful attainment of this object. India now supplies this country with over $3\frac{1}{4}$ millions of cwt. of wheat, or between $\frac{1}{13}$ and $\frac{1}{14}$ of its total imports of that grain, and with the exception of the United States of America and Russia, it furnishes us with a greater amount of wheat than any other country. The advantages that would follow a vast increase in the exports of wheat from India to England would be shared by our merchants and shipowners, as well as by the growers, whilst the demand that a more scientific system of agriculture would cause for improved implements and machinery would also benefit the manufacturers of this country. Exclusive of Bengal and Assam, the area of British India under cultivation amounts to 119,523,596 acres, whilst there remain 316,427,764 acres uncultivated. It would thus appear that, after allowing ample margin for towns, pastures, forests, fallows, and other lands not immediately available for cultivation, there must yet exist immense areas capable of being brought under the plough, and awaiting only the industry and energy necessary to cause them to bring forth fruits for the service of man.

DISCUSSION.

Sir Arthur Cotton said that on the subject of water he ventured to speak with authority, but agriculture he had not paid so much attention to, and he felt that he was speaking in the presence of one of the most eminent agriculturists in England. Still he had paid some attention to the subject, and it had been forced upon him continually, in consequence of the mode in which he had been mixed up with the agricultural population of India. With respect to introducing English ideas and improvements into India, he might tell a story. They had once an eminent Scotch agriculturist as governor of Madras. He had never before been in a tropical climate; but almost immediately on his arrival,

he was sitting at breakfast one morning with a number of gentlemen, and made the remark that wheat could be grown anywhere, and that he could grow it in the garden. There was an immediate shout of laughter, especially when he added that by under-draining the ground you could grow anything. The idea of under-draining ground in India, where the great want was that of moisture, seemed quite absurd. However, he took down the names of all present, and soon after he sent all a present of a loaf of bread and some potatoes which he had grown in his garden in Madras. This was an amazing encouragement to the introduction of intelligent English farming, and nothing had given him so much satisfaction for many years as the appointment of a leading English agriculturist to the famine commission in India. He was full of confidence in this appointment for the improvement of agriculture in that country, and did not think that Mr. Danvers could have done a greater service to India than by bringing forward this subject. There were several points on which the paper touched, particularly those with which he was especially connected, namely, irrigation and transit. With respect to manure, one of the greatest evils in India was the use of manure for fuel. No country could stand this for any great length of time, unless there was an enormous disproportion of uncultivated land on which they could pasture their cattle. The only remedy for it was cheap transit, so as to enable the people to bring fuel from the forests and the coal districts, and thus release them from the necessity of burning manure. There were unlimited supplies of fuel in India, both wood and coal; all that was wanted was means of conveyance and distribution. With respect to the quantity of water, one of the greatest defects in the management of the irrigation question had been the not charging for the water by the cubic yard. Of course, if a man had to pay 4 rupees an acre, he must use as much water as he possibly could, so as to give him the most valuable crop; the question with him was not whether he could grow a certain value of crop with a certain quantity of water, but whether he could grow a certain quantity on an acre of land. He was, therefore never put to the question, whether it was more beneficial to grow an acre of rice or four acres of wheat or any dry grain. But if the water were charged for by the cubic yard, then he would consider how to turn it to the best account. He had no doubt that if you were to employ 6,000 cubic yards of water to produce a crop it would be far more productively applied to four acres of dry grain than to one acre of rice. Therefore, one of the great things in the irrigation question was how to give the water to the people in such a manner as to encourage them to turn it to the greatest account. For instance, the water they used for irrigating 7,000 acres of rice in the Godavery district would irrigate three million acres of dry grain, and no doubt would be far more beneficial. With regard to the quantity of water required, it was stated in the paper that in the Godavery district they used 9 ft. of water besides the rainfall, so that it would take about 4 yards of water, or of 18,000 cubic yards, to bring a crop of rice to perfectioa. He had had long experience in this matter, and could say that not only was 6,000 cubic yards ample, but it allowed for a great deal of waste. Whether more could be used so as to produce a larger crop was another question; and it was very remarkable that the gentleman in charge of the model farm of Mysore had lately tried that, and found that employing double the quantity of water to the crop greatly increased the produce of rice. Still, that might be very wasteful, because an additional 6,000 yards might be better adapted to a larger extent of rice, or to a still greater extent of dry grain. There was one very important point to be kept in view with respect to water. There were, in agriculture, four entirely different kinds of water—well water, rain water, tank water, and river water—which required to be applied differently. The rain was almost simple moisture; the well water was either simple moisture, or it was very much injured by the minerals which it had absorbed, and sometimes was perfectly destructive to vegetation. The tank water had washed a large extent of country, and came down loaded with a great quantity of manure, both in suspension and in solution. What it carried in suspension was mostly deposited in the bed of the tank, but what it held in solution it conveyed to the land; and, therefore, tank water was itself exceedingly rich in manure, and, he believed, almost entirely renewed the land. He had known very little manure indeed used on any of the tank lands he had come in contact with, but they never diminished in produce. Then came the rich river water, which was loaded with manure, both in suspension and in solution; and so complete was the effect of that river water on the land—in the rainy season, when the rivers were more or less in flood—that they perfectly renewed the soil. Tanjore had been irrigated for 2,000 years, and there was not the slightest sign of the land becoming less productive than it used to be, nor was there any tradition at all which would support the idea that it was diminishing in productiveness. Sometimes, it was said that if you continued to irrigate the land for the same crop, in time it would become totally unproductive; but that was utterly inapplicable to river irrigation. The great mass of irrigation in India was from tanks or rivers, in both of which cases there was no deterioration of land, but, on the contrary, up to a certain extent, a continual improvement. Therefore, he could not understand at all what was said about the diminution of produce. What were they to think of the statement that, in the last 10 years, it was not producing one-half what it did before, when there were thousands of millions of acres, which had been cultivated from time immemorial, in which there had been no diminution. There might be some tracts where the produce had lately fallen off, but they should be specially careful not to treat peculiar exceptions as a general rule. Men were killed by railroads in England, but not every man who travelled by them; and one of the grave causes of false judgment was taking hold of some isolated fact and speaking of it as if it were a general thing. So with respect to subsoiling. A friend of his had a farm in Wales, the subsoil of which appeared to be absolutely poisonous and incapable of producing anything; there were pits on the farm, which had been levelled down so as to be ploughed over, and not only was there not one ear of grain or blade of grass of any kind growing on the side of these pits for years, but neither was there anything else. That was quite an exceptional case, and they must always distingush between subsoil ploughing and bringing up the subsoil to the surface. Having had many long discussions with the Governor of Madras, Lord Tweeddale, he was exceedingly anxious when he came home to England to see that nobleman's farm, where he had had full liberty to do what he pleased. He went and saw it, and found it not only equalled his expectations, but surpassed all that his imagination could conceive of what cultivation would do. He saw clean furrows 16 inches deep on land which had just produced 40 bushels to the acre, and that furrow was in better tilth than almost any gentleman's kitchen garden in Surrey. Mr. Stephens, the great agriculturist of Scotland, was with him, and said that before the Marquis took this in hand he had seen this land laid up in narrow lands as steep as the roof of a house only growing oats, and a row of rushes between every two lands, yet it had just produced 40 bushels of the finest wheat in Great Britain. That showed the difference between good and bad agriculture, and this was what might be expected if intelligent skilful English agriculturists were sent to India. Almost the whole of India was virgin soil, that is to say, it had never been cultivated above 3 or 4 inches deep. The other day, the farmer of the Government model farm in Bangalore ploughed up a field 5 inches deep by the side of a native farmer's land; he told the native farmer to cultivate his land in the usual way and he would cultivate this, and the next plot of

exactly the same land he ploughed 8 inches deep. It was a very dry season, and on the native land there was not one ear of corn. On the 5 inch ground there was a fair crop, and on the 8 inch deep land there was such a crop as he had never heard of all the time he was in India—two tons of clear grain to the acre, or about 60 or 70 bushels, which was ten times what the land usually produced. This was simply the effect of a deep cultivation of that particular land. He looked on these model farms as one of the grandest institutions which could be promoted by the Government, and he must say he differed *in toto* from the sentiment expressed in the extract from the Bengal report on the subject of that farm. It was impossssible that words could be more contrary to his view of the matter than that. In fact it was utterly subversive of all progress whatever. It was impossible to conceive of the benefit the model farms had been to India. At this very moment an improved breed of sheep, more suited to the Indian climate, was being introduced by careful selection on the Madras farm, and when you thought what the introduction of that improved breed would do for the 240 millions of people in India, the failure of 100 model farms would be utterly insignificant compared with such a result. He would have at least one model farm in every district of India, where the farmers could come and talk over their matters with the Englishman, see what he did and what implements he used. The natives were extremely anxious for improvement, and incomparably more teachable than Englishmen, and if model farms were brought within the reach of the natives the progress would be ten times as rapid as in England. It was a very common excuse for indifference to say, "Oh, you cannot teach these natives anything," but nothing could be more contrary to the fact. He once cut a canal through a tract of country where they had never grown a blade of rice, and had not the slightest idea how to cultivate it. He ran this canal for 10 or 15 miles through this tract of country, and in the second year he had an opportunity of going to look at it. They had gone to the expense of levelling the land, making embankments, learning how to grow and transplant rice, and every acre looked as if it had been in cultivation for 20 years. He would put it to anybody acquainted with agriculture in England to say how long it would take to introduce a totally new method of culture into Surrey, and whether in the second year he would see the whole country alive with the new crops. Every possible excuse was sought for to prevent setting to work to improve the condition of India, and we ought to be on our guard against these things. Only the other day, he read in a newspaper the astonishing statement that when the engineers were making the grand trunk road from Calcutta to Allahabad, they had to encounter the greatest opposition from the collectors and civilians along the whole line; their difficulty was with them, and not with the natives. When a ship was under weigh, it was absolutely necessary for the captain to take account of the current against him, and in dealing with these Indian questions, the astonishing bias of the old India-house party against all improvement must be continually kept in view. He looked upon plantations as a matter of immense importance, next to improved cultivation. In fact, the four things he wanted to see for the good of India were:—first, cheap transit; second, irrigation; third, deep cultivation; and fourth, plantations; and he was convinced after 50 years' experience, that India might be brought into a perfect garden, if these four things were attended to.

Mr. Dutt said the importance of this subject was manifest when one recollected that 90 per cent. of the exports from India were raw products, such as rice, opium, cotton, &c. By improving the old Indian system of agriculture he was sure that in a short time the total produce would be doubled or trebled, but the attempt to introduce a new system would probably be a failure, like the experimental farms of the Government. He would not say they were actual failures as schools, but financially they were. It was never intended that these farms should pay, and when they tried to introduce a new kind of cotton, as for instance in Berar, then failure was almost sure to follow. The introduction of Carolina rice had been a failure, because the land was not suitable to that kind of rice. The same with the introduction of American cotton seed; but if they observed carefully and scientifically various kinds of cotton and wheat, and selected those which were best adapted to the country, and tried to improve them, it would be a success. With regard to deep ploughing, it did not suit Indian rice. It was a surface feeder, not like the Carolina, which was a deep feeder. The cultivation of Indian rice required a larger quantity of water than wheat, and different kinds required different quantities of water. For instance the spring rice, which was gathered in September, required less than the winter rice, and did not require much manure. In some parts, however, they used a manure which was not known to many people in India, namely, the leaves of the jute plant, which was now largely cultivated in Bengal, and made splendid manure. In the North-West Provinces the manure was carefully preserved, and they paid so much to the shepherds to have their sheep and cattle pastured on the ground. Still he knew that a great deal of manure was wasted. With regard to the planting of trees, there was one advantage which had not been noticed, namely, that this would tend to attract clouds and bring rain. In the Island of Ascension not a blade of grass could he seen except on what was called the Green Mountain, which was perfectly covered with vegetation, owing to the trees attracting the clouds. So with the districts in the western part of India, especially where the average fall of rain scarcely ever exceeded 10 inches; in this part they would be doubly benefited by plantation. In Lower Bengal it would not be necessary because the average rainfall was from 50 to 60, and sometimes 100 inches. The experimental farms and horticultural societies had done great good in introducing various new kinds of vegetables, for instance, cauliflowers, potatoes, and cabbages. Other vegetables would also grow there, because every kind of climate was to be found in India. But there was one important subject which seemed to have been omitted, and that was meteorological observations. There was such an intimate connection now established between meteorology and the science of agriculture, that one of the most important things to be done now was to establish all over India, not only experimental farms, but meteorological observatories, to note down the atmospheric pressure and moisture, with the various other changes. This subject was now attracting the attention of the Government, and he hoped in a short time there would not be a single district where there would not be such an observatory established.

Mr. Elliott being called upon, said he did not come for the purpose of speaking, he seldom addressed the Society; and the last time when he came down with some valuable correspondence recently sent him by an officer in Mysore, he was interrupted, and not allowed to finish the remarks he was making. As it happened there was no one then in the room more competent to speak on the subject before the meeting, and he took that opportunity of making a suggestion that it should be the duty of the Chairman to find out those who had the most practical knowledge of the subject in hand, write to them beforehand, and ask them to express their views. Before sitting down he would make one remark as to an observation of Sir Arthur Cotton's, who had found fault with a quotation from the Bengal report. Now a similar remark was made by Lord Mayo, who said it was no use preaching to the natives about agriculture without first of all finding out their ways, habits, and difficulties, and having discovered them you might be able to suggest a method of overcoming them. There was not a more

practical remark in the whole of the paper, than that passage which Sir Arthur Cotton held up as of no value whatever. Sir Arthur Cotton had also spoken of river water as being invariably of great value, and though he had not said anything about canal water, yet the meeting might infer that that also was of great value. That might or might not be so, but in Egypt it was frequently found that canal water was of no manurial value whatever, because by the time it was taken from the river on to the land it had deposited all its valuable constituents, so that it was of little more value than any other water would be.

Rajah Rampal Sing said native cultivation depended on three or four things which had already been stated, namely, cultivating deeply, properly manuring and watering, and he was sorry to say they were all defective. Their bullocks were not strong enough to drag heavy implements, and even if they were, the men also could not be compared to the people of this country, because they were not so well paid. A working man there was only paid 3d. per day at the outside, whilst here the lowest pay was one shilling, and his food could not be compared to that of Englishmen. Manure, as had already been stated, was used for fuel, the people being so poor they could not afford to get wood. Water was also difficult to get; in his State there was no river; getting it from wells was very difficult, and generally required two bullocks and one man for each bucket, which brought up each time three or four pitchers of water and took ten minutes in the process. That quantity was hardly sufficient for a quarter of a beegah, $2\frac{1}{2}$ of which went to the acre. In taking it from ponds they had a kind of basket which brought four or five pitchers, but it required two men for each, and they had to be changed, so that it really took four. When a man wanted to irrigate his farm he would get his friend to come and assist him, and he would do the same thing for him at another time. Those were the sort of obstacles, and unless they were removed you could not expect much improvement in India. If the system were changed, the men better paid, and there were machines for drawing water, great improvements might be expected.

Mr. Cotton (Bengal Civil Service) said he was the writer of the report which had been criticised by Sir Arthur Cotton. He of course wrote those remarks as representing the views of the Government of Bengal at the time, but they also represented very faithfully his own opinion, and he could only say that all the model farms in Bengal had failed in a financial point of view. They were started with every prospect of success, Sir George Campbell himself being enthusiastic in their favour, and he got the best men he could to manage them. But they not only failed financially, but in an agricultural point of view, for the out-turn of the crops had not been equal, in a single farm, to that which was obtained by ordinary farmers on adjoining ground, of precisely similar nature, cultivated by their ordinary modes of procedure. He did not know much about the Madras Presidency, and, no doubt, the Marquis of Tweeddale seemed to be more successful; but in Bengal he had never known an instance of scientific agriculture succeeding. He made these remarks in vindication of the native method, which, it seemed to him, was remarkably good. The tendency of people who were accustomed to a high system of cultivation, when they went to India and saw the land cultivated in a simple way, was to say that it was very bad, that the out-turn was not so great as was obtained in England, and ought to be enlarged. But most people, when they had been in India some time, changed their opinion in that respect. The most important crop, in Bengal at any rate, was rice, and the cultivation of that plant was very simple. He had himself sown splendid crops of rice with his own hands, without any cultivation at all. It was true the natives ploughed very scantily, but, previous to ploughing, they performed a process which was very important. Eight or ten of them stood in a row, with a large, heavy hoe, and hammered on the ground, bringing up enormous blocks of earth, 2 ft. or 3 ft. square, which, of course, had the effect of turning up the soil considerably—much more than ploughing would do, and then, after being again hoed, it was scantily ploughed over. With regard to arboriculture, the Indian Government had gone into that to a very great extent, but it depended very much on the idiosyncracies of different collectors, and proceeded better in some districts than in others. In some parts there were considerable groves of trees by the side of the roads, which were very convenient on account of the shade, but he did not think they were of much use beyond that. In Bengal, at least, no amount of encouragement of planting trees would improve the agriculture, because the natives themselves had such enormous masses of foliage, groves, and jungle about their own houses. When he last was in India the cry was for cutting down the jungle because there was a good deal of fever, and it was attributed to the excessive amount of vegetation and jungle, and for years they cut down as much as possible. Then came a reaction in favour of preserving the trees; but he did not think it mattered much as regards the crops or the health of the villagers which course was adopted. Assuming it to be desirable to introduce improved methods of agriculture, there was the great question of cost, which must be considered, and he took it the improved plough would be more expensive. If the natives saw an advantage they would not scruple to go in for any extra expense, for no people were quicker, when they saw their interests were involved, to take an advantage of improvement; but they required it to be proved first. That was why they would not go into irrigation in Bengal, because it did not pay. So in the same way they would not take to model farms or improved ploughs. It did not seem to them to pay, or to the Government. The Marquis of Tweedale, no doubt, had been successful; but, as Sir Arthur Cotton had said, they must not argue from particulars to generalities.

Dr. Balfour said he had not been connected with the Forest Department, but he had very carefully read almost everything issued by it since it was formed, and his own impression was that planting trees was of great importance. All that Sir Arthur Cotton had advocated with regard to irrigation had been constantly in his mind since he went to India, about 36 years ago. He had no doubt there had been great neglect as to providing means of irrigation and additional planting. Mr. Robertson made a report last year on the district of Coimbatore, in which he mentioned that during the last twenty years the quantity of land under irrigation there had not increased; that was much to be regretted, and it showed that the matter had not been sufficiently attended to, and this was all the more important, bearing in mind Sir Richard Temple's remarks on the famine in Madras, wherein he stated that one-half or one-third of the tanks were broken down. Twenty-three years ago it was his duty to report to the Government on the iron manufacture of the country, and as the only fuel used for smelting ore was wood, he became acquainted with the fact that the forests were diminishing to a degree quite beyond the belief of any one who had not had the evidence duly put before him. It had gone on every year, and every year the forests were getting further away from civilisation, and the price of fuel had become higher and higher, until now it was 300 times as high as it was 25 years ago. As there was no coal used, the quantity of wood required was about 2 lbs. per head per day, and unless care were taken great distress must result. That which caused the greatest consumption was the introduction of railways. They used solely firewood, and it was impossible for a large number of engines to go on running even for a month without making enormous changes. He first went through the mount in border of Cuddapah nearly 40 years ago, and it was then a dense forest for about thirty miles; he went through it again

only the year before last, and there was not a particle of forest remaining along the whole track of the railway. It was all under cultivation, but it had altered the face of the country altogether. Although a great deal of good had been done by the irrigation works on the Godavery, the Kistnah, and the Cauvery, he thought sufficient attention had not been paid to the looking after the smaller tanks. His own impression was that the Government, which had now taken possession of the whole of the tanks in the country, had taken upon itself the duty of looking after them, and he could not but think that by more care of these smaller tanks on the higher grounds India would be greatly benefited.

Mr. Cornelius Walford said that he knew Mr. Danvers had had occasion to pay attention to one subject which had been of so much moment in connection with India lately, namely, the famines, and through his friend Lord George Hamilton he had been enabled to see the very able document prepared by Mr. Danvers on the whole of the famines of India; and when he found Mr. Danvers was bringing forward a paper on agriculture, he could not help putting the two things together, and feeling that Mr. Danvers, after very careful consideration of the famines, their history and causes, had come to the conclusion that the only means by which these great calamities could be averted was an improved agriculture. If that were so, he must have the sympathy of all parties connected with India, and who were concerned for the progress of the whole human family. Anything more terrible than the records of those famines could not be conceived, and if Mr. Danvers, after mature consideration, and with all the resources of the Indian-office at his command, had come to the conclusion that an improved agriculture would avert famine, every one must feel that this was a problem which required immediate solution; and in the Chairman's hands he felt sure the subject would not be lost sight of, and he hoped, therefore, most earnestly that a solution would be found of this most difficult and pressing problem.

Mr. Collins (late Government botanist in the Straits Settlement) said he had had a great deal to do with the questions raised by the lecturer during the time he held an official position in the East, and the way Mr. Danvers had dealt with them must have given pleasure to anyone who had had any experience of Indian agriculture. One point had struck him which sometimes those who stayed at home lost sight of, namely, the amount of prejudice which had to be overcome. Very often in trying to introduce improved systems, when he had gone over the cocoanut or tobacco plantations, and had said to the Chinamen (and they were men who would pay attention to anything if they thought they could turn a dollar by it) "why do you not do so and so?" Their answer was "what is the good; what shall we get out of it?" That was always the first question. They would work away with their "chankles," and only laugh at you if you showed them a plough. Major Tudor, the American Consul at Singapore, took the trouble at his own expense to introduce a very good plough, and Sir Andrew Clarke, the governor of the Straits Settlement, lent all the assistance he could to try and get some of the Chinese to use it; but they said, "No, our men will not use it." They would keep on with their "chankles." Mr. Markham made a remark a few years ago in one of his reports on India, which had some bearing on this question, namely, that the only outlet for the population in India would be in agriculture, because in the bazaars the native manufactured goods were being supplanted by those made in Europe. He thought at the time that this might be a slightly mistaken view, but whilst in the East he found that on going into the bazaars to get native garments the people would recommend them European ones as being in their idea better; in fact, to get a native-made garment was very difficult indeed. If this went on it would throw many people into agriculture who otherwise would go into trade. As to the diminution in the value of the land, it was not at all astonishing when one saw the way in which agriculture was carried on. People would go to the Government and get an order to clear; they would cut the trees down, or ring them, and set fire round them; the trees would fall, and they would plant there pepper or gambier, until the land became exhausted, and then they would go and get another "order to clear" and treat a fresh track of land in the same way. If you went back to the old track, you would find that the process of fallowing, instead of improving the land, made it worse than before, because a very tenacious kind of weed spread over the ground, which was very much more difficult to eradicate than the "prairie grass" in America. This was the case in Singapore and Malacca to a great extent.

The Chairman, in asking a cordial vote of thanks to Mr. Danvers for the very interesting and instructive paper which he had read, said that he had come there to learn, and had had the advantage he had anticipated of hearing a discussion which covered many sides of the great question of India. They had heard the views of Sir Arthur Cotton on the subject of irrigation and the convenience and cheapness of water carriage, and they had been favoured with the opinions of two native Indian gentlemen from the Indian point of view. The civil branch of the service had been ably represented by Mr. Cotton, whose testimony in favour of the aptness of the native cultivator to turn to account any proved improvement of practice was encouraging. For his own part he could not help thinking that India, which maintained a population to the square mile greater than that of either France or Germany, both of which have other important industries besides agriculture, must be a richer country than that she is often represented to be. Her soil must be unusually rich, if her agriculture is so very defective, otherwise she could not maintain so dense a population. There is, indeed, no plant of value which cannot be produced in India; and we, for the last three unproductive years, have received great help, both by direct supplies and the consequent check to the rise of price, in the increasing quantities of wheat she has been able to send us, and which in 1877 reached one-ninth of our total foreign supply. With a fertile soil, an abundant supply of labour, extensive railway communication on all the main lines of travel, and vast work of irrigation already executed, it cannot but be that India under wise Government, and with time, must prosper. If he should have the good fortune to return from India, he might be able to speak from personal knowledge next year on the subject, one branch of which it would be his duty to investigate. That the elements of prosperity were there was unquestionable, and this country had undertaken a responsibility for their proper use, which could not, either with safety or honour, be neglected.

Mr. William Botly seconded the vote of thanks, which was carried unanimously.

Mr. Andrew Cassels writes as follows:—I was present at the meeting of the Society on Friday evening last, when my friend, Mr. F. C. Danvers, of the India-office, read a most interesting paper on this important subject, and Mr. Caird, the eminent English agriculturist, occupied the chair. I should have wished to say a few words on the occasion, but I found myself surrounded by so many gentlemen who were eager to speak, some of whom were far better acquainted with the subject, and better entitled to be heard than myself, that I remained silent. Perhaps you will allow me to put in writing that which I should then have put in words if time had permitted. I have long been of opinion that no subject connected with India is more important, and better deserved serious consideration, than the state of agriculture throughout the Empire. It has always seemed to me that the subject has not met with the attention it deserves, though

two-fifths of the revenues of the State are derived from the land, and any increase in the productiveness of the soil would be as beneficial to the Government as to the agricultural classes themselves. I was looking through some old official papers a few days ago, and I found that in one of their despatches written in 1854, the Court of Directors of the old East India Company expressed an opinion that there was no "single advantage that could be afforded to the vast rural population of India that would equal the introduction of an improved system of agriculture." In 1870, Lord Mayo, then Governor-General of India, used the following words in a despatch to the Secretary of State:—"We believe agriculture, which constitutes the occupation of the great mass of the people, to be susceptible of almost indefinite improvement. . . . . It is hardly too much to say that scientific knowledge of agriculture in India has at present no existence." These weighty words show that successive Governments of India have not been blind to the fact that much might be done to increase the productiveness of the soil, and something, if not all that enthusiastic advocates of progress have desired, has been done to spread a more scientific knowledge of agriculture, and to encourage the adoption of improved ploughs and other implements among the people. Experimental farms have been established in various parts of the country, and many officers of the Government have, by precept and example, striven to show what care and knowledge can do to increase the productiveness of the land. It was, then, with regret and disappointment that I heard Mr. Cotton, of the Bengal Civil Service—and no mean authority on such matters—say that to his knowledge all the experimental farms in Bengal had been failures, and that experimental farmers in India would do well to watch the process by which the agricultural classes in India cultivated the soil rather than to endeavour to introduce a newer system among them. If I have misunderstood Mr. Cotton, I shall be heartily sorry that I have used these words, and I trust he will pardon my mistake. But I have heard other old Indians speak in much the same terms—and I wish to point out that if he and those who think with him are right, then the Court of Directors in 1854, and the Government of Lord Mayo in 1870, were wrong. Is it, indeed, a fact that all experimental farms in Bengal have been failures? If so, in what sense have they been failures? Is it because they have not, in their financial results, covered the cost of the well-paid officers, who have had the care and management of them? Or is it asserted that in productiveness they do not show any improvement on the old systems of native agriculturists? It certainly appears to me that there can be no better way of teaching the natives what scientific agriculture can do than by establishing farms of this description, and by drawing the attention of the people about them to the results obtained by proper farming. I do not admit that an experimental farm is a failure because it may not cover its expenses, including the salary of its superintendent. It may not have been properly managed; for I confess I have often been vexed to see the lavish expenditure of these farms upon manure and one thing and another—an expenditure which no ryot can afford—instead of a scientific application of such means as are within the reach of the native cultivator. I shall be heartily sorry to see these farms given up; on the contrary, I would give greater support to them, I would engage the very best men for managing them that care and money can secure; for, I believe, that a large expenditure upon good agricultural teaching in India would, in all human probability, eventually prove to be as profitable an investment as the Government could make. In much that Sir Arthur Cotton said on Friday night I heartily concur, always excepting his attack on the officials of the Government of India. I have also lately read the pamphlet published by Mr. Harman, superintendent of the Bangalore experimental farm, to which Mr. Danvers alluded in his paper. I have not the pleasure of being acquainted with Mr. Harman, nor am I able to judge whether his statements and figures deserve implicit credence or not, but he writes as a man writes who knows what he is about, and who is convinced of the truth of the assertions he makes. I was much struck by many of his remarks. If he is right, there can be little doubt that in and about Bangalore, at any rate, the land does not now yield such heavy crops as it used to do. The soil appears to have undergone a course of gradual exhaustion. One of the speakers on Friday night spoke of the soil of India as being a "virgin soil" because the surface of it only had been used! How far down does this gentleman think we can go without touching the "virgin soil" he talks of? To my mind the soil of India is rather an old and worn out soil that requires rich manures and careful nursing for its restoration. But the point to which I should particularly have drawn the attention of the meeting, if I had had an opportunity of speaking, was this—Is the state of agriculture in India owing to the poverty of the people? And if so, ought we not to extend our inquiries into the land tenures of India? Are the terms upon which the land is held in that country by the agricultural classes so onerous that the soil is, by reason of their poverty, starved? It seems to me that the condition of the people is the thing to be chiefly looked to in any inquiries we make into the state of agriculture of a country. I am quite aware that in saying this I open the door to a discussion that would occupy many evenings instead of one. I do but allude to it as being, in my mind, at the root of the whole question. That it must force itself upon the attention of so able and so experienced a man as Mr. Caird, when he enters upon the official duties to which he has been appointed, I doubt not, and his well-known independence of character will give great weight to anything he may hereafter say or write on this great subject. To no one has his appointment given greater pleasure than myself.

TWENTY-SECOND ORDINARY MEETING.

Wednesday, May 22nd, 1878; WILLIAM HAWES, F.G.S., Deputy-Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Dutt, K. M., 15, Colville-terrace West, Notting-hill, W.
Egmont, Earl of, 26, St. James's-place, S.W.
Hargreaves, John, Maiden Erlegh, Reading.
Hickin, Henry, St. John's School, Holloway, N.
Sing, Rajah Rampal, 15, Colville-terrace West, Notting-hill, W.
Stott, Henry, Greetland, Halifax.
Walton, Jonathan Sparke, 15, Bouverie-street, Fleet-street, E.C.

The following candidates were balloted for and duly elected members of the Society:—

Baillie, Captain William, 43, Norfolk-square, Hyde-park, W., and Duntsbourn, Cirencester.
Leon, George, 79, Gloucester-place, W.
Milburn, Robert, 63, Queen Victoria-street, E.C.
Notman, Henry Wilkes, F.R.G.S., Cholmley-lodge, West-end, Kilburn, N.W.
Rathbone, Theodore, F.L.S., J.P., Backwood, Neston, Cheshire.
Ronchetti, John B., Bradford, Manchester.

The paper read was—

CONTROLLING AND CORECTING CLOCKS BY ELECTRICITY.

By Freaerick J. Ritchie.

The growing appreciation of the value and the importance of correct and coincident time in all the relations of commercial life, as well as the necessity of observing punctuality in connection with the railway, postal, and telegraphic arrangements, will, I trust, form a sufficient apology for my endeavouring to indicate some of the methods which have been employed to attain these results; and may, I trust, tend to a more extensive publication of exact time than has hitherto been accomplished throughout the country, and especially in our great commercial centres.

To obtain the first of these requisites, namely, correct time, we have in Greenwich, Liverpool, Edinburgh, Glasgow, Aberdeen, and some other of the principal towns, observatories, provided with clocks specially constructed for astronomical purposes, fitted with compensation pendulums and delicate refinements of mechanical appliances, for preventing the changes in temperature and barometric prrressure to which we are so subject, and which so much affect their timekeeping qualities. These clocks are compared day by day with the transit of the sun, or some of the so-called clock stars, and have their errors eliminated from time to time by a thoroughly trained staff of observers. The errors may be small; but for astronomical purposes a small error represents a large amount of space, and, in nautical life, the danger of a wreck or a leeshore.

Having obtained the correct time in this way, it becomes not less important for the general public to secure coincident time in all our clocks, a matter which has not yet received the attention which it deserves. Shortly after the introduction of railways, it became apparent that uniform time must be observed throughout the land, and it soon led to the introduction of Greenwich mean time as the standard in Great Britain, instead of each town using its local time.

Consequent on the introduction of uniform time and to meet the growing demands, Greenwich Observatory early initiated a system of time signals, which were and still are sent to all the principal towns both in Great Britain and Ireland. At 10 a.m., and again at 1 p.m., a chronofer in the London Post-office is put in connection with the Greenwich mean time clock, and automatically repeats its time along the ordinary lines of telegraph wires, which are, by the apparatus, cut off from the instruments. These signals consist of the deflection of a small magnetised needle for about 20 seconds before the hours indicated, followed by the sudden reversal of direction in the needle, this change indicating the exact hour. The annual charge, however, made for such signals, proves obstructive to anything like general adoption even by watchmakers, while, from its very nature, it can only be made available to a few, and is entirely beyond the reach of the general public. As a further and more public means of indicating correct time, especially to the maritime portion of the community, and with a view to enable them to compare and rate their chronometers, a large ball has been erected on the roof of the Greenwich Observatory, which being raised to the top of the mast by mechanical means, is allowed to drop exactly at 1 o'clock.

The utility of such a signal being at once acknowledged, several of our large seaports adopted the ball signal; and lately some watchmakers throughout the country have erected balls in their windows or had them attached to their premises, which are dropped by currents from authorised sources.

The Edinburgh Royal Observatory very early introduced and erected such a ball signal on the summit of Nelson's monument, on the Calton-hill, which, standing at a height of 460 feet above the sea level, and projected against the clear sky as a background, is clearly seen from a great distance in every direction. Originally the electric current which withdrew the trigger, and allowed the descent of the ball, was transmitted by hand at the mean time clock in the Royal Observatory, but shortly after its inauguration, our house* applied an automatic apparatus to the clock itself, which completed the circuit, and rendered the signal more correct and certain in operation.

A citizen of Edinburgh, Mr. John Hewat, on his occasional visits to Paris, had observed the small cannon which is fired by the action of the sun's rays, passing through a lens, at noon solar time, and conceived theidea of a time signal, which would prove more generally useful from its audible as well as its visible effects. By his exertions, with the support of the Chamber of Commerce, a considerable sum was subscribed to defray the expenses, and in the month of June, 1861, the daily time gun was inaugurated at Edinburgh, and has since, with remarkably few exceptions, proclaimed the hour of one p.m., true, not only to a second, but to the smallest fraction of a second. This accuracy I shall afterwards refer to in connection with the controlled clocks.

Newcastle and South Shields followed the example in 1863; and in Glasgow an attempt was made to fire three guns, but no good position could be obtained for them, and they were consequently discontinued. In 1867, we fitted up one for the Mersey Dock Estate, upon the Birkenhead shore, in connection with the Liverpool Observatory at Bidston. In 1872 we established a gun at Dundee, which is fired by a clock in the Post-office, in connection with the Edinburgh Royal Observatory, and in 1875 we fitted up time guns in Cork and Queenstown, the latter of which immediately faces the entrance of the famous Cove of Cork, and is of immense service to the fleet of ships constantly visiting that celebrated harbour. Besides these, a few other cities have moved in the direction of time guns, while a few private noblemen have adopted this form of signal, conspicuous amongst whom stands the name of Lord Lindsay at Dunecht.

The gun signal has the advantage, even as a visible signal, over the time ball, as the flash and volume of smoke are so clearly distinguishable, occupying a much larger field than the ball, and are, of course, instantaneous; while the audible signal follows, corresponding with the distance of the observer. These signals, however, are only as one means to the desired end, as they occur but once a

* James Ritchie and Son, Edinburgh.

day, and are thus of very limited use as compared with clocks, to which appeal may constantly be made; and we shall now notice what has been done to secure coincidence of time in any number of clocks.

Previous to the year 1840, many attempts were made to cause clocks to move in unison with each other, but without success. With the introduction of electricity, however, and its application to horology, the problem was gradually solved, and in the course of a few years any number of clocks have been made to indicate coincident time, and their pendulums to vibrate in complete unison with each other and the governing clock, and that unceasingly so long as the controlling power was maintained.

It is not my intention here to enter into a detailed history of the several steps of the application of electricity to clocks, but I shall merely notice a few of the most successful results which have passed immediately under my notice. Electric clocks, or what have hitherto been so called, may be classified under three divisions.

1st. Those whose motive power is wholly electric, and which are wholly independent of any other force whatever.

2nd. Those depending on currents of electricity transmitted at regular intervals, and applied directly to carry forward the wheel-work and hands.

These two classes require no periodical winding up, and may properly be styled electric clocks.

3rd. Those, which being complete clocks in themselves, and capable of performing all the duties of clocks without the external aid of electricity, show their own time, and require winding up at certain intervals, but for the purpose of being made more useful and correct timekeepers, have currents of electricity transmitted from some standard clock, so applied as to control and correct the vibration of the pendulum or the movements of the wheel-work and hands, and so cause them to show uniformity of time with the governing clock.

In the year 1840, Mr. Alexander Bain, a native of the North of Scotland, and well known in connection with the electric telegraph and clock, constructed an electro-magnetic pendulum, which, for simplicity and efficiency, has as yet been unequalled, combining a minimum cost and expenditure of force and material, with the smallest chance of derangement. It was based on the discovery of Professor Oersted, that when a current of electricity passes through a wire a magnetic action is induced, which affects the needle of a compass placed near it, the influence being increased by coiling the wire several times round the compass, whilst the reversal of the current in the wire changes the direction of the needle. Mr. Bain constructed his pendulum by using a helix of wire, each turn insulated from the preceding, for the ball or bob, the wire ending in two insulated springs by which the pendulum is suspended. Fixed to the clock case, and with perfect freedom for the oscillation of the pendulum over them, he suspended two bundles of permanent magnets, having their similar poles slightly separated in the centre. The pendulum was caused to complete the galvanic circuit by a sliding bar resting on the battery terminals acted on by its vibration, and thus rendered automatic, while its movements were recorded by wheel-work carried forward by each alternate oscillation. Considerable irregularity in timekeeping, however, was caused by the friction of the bar, and also by the unsteady action of the battery.

Time will not allow me to mention other attempts to obtain more steady timekeeping by means of electricity, applied directly to drive the pendulums. Nor yet shall I notice those clocks included in my second division, in which not only electro-magnetism, but also magneto-electricity, has been employed; but will now pass on to the third division, or those clocks which, complete in themselves, have electricity applied to control or correct their movements, and cause them to show coincident time with the normal clock.

Of all the methods yet proposed or carried out to secure coincident time to a fraction of a second, none can bear comparison with that introduced by Mr. R. L. Jones, and I beg to bring it under your notice to-night. Not for its novelty, for it dates back about 20 years, but because I feel that it has not met with the success in the City of London which it merits, and, I believe, is yet comparatively unknown to the great majority of scientific men. I speak from practical experience with its operation during 17 years, having supplied clocks controlled in this way to the principal observatories, not only in this country, but in the United States and Russia. I, therefore, ask your indulgence while I shortly explain its action, and that in a very popular manner.

Mr. Jones, then manager of the railway station at Chester, had his attention called to electric clocks, and attempted, by means of large electro-magnets, to drive the hands of a large dial within that station. After spending much time, labour, and expense, and covering the floor of a room with batteries in alarmingly increasing numbers, the happy thought occurred to him that, as Mr. Bain had succeeded in driving, not only his pendulum, but his clock, with the small power obtained from a copper and zinc plate sunk in the earth, surely Mr. Bain's pendulum, if applied to and driven by an ordinary clock, could be caused to vibrate in unison with that of an astronomical clock, if such were employed to transmit currents to it at regular intervals.

The success of the experiment was soon placed beyond doubt, and the large clock, which no battery power was found sufficient to drive, was kept in check and caused to beat in coincidence with the normal clock. Afterwards, an old and cumbrous clock in the Victoria Tower in Liverpool, having six dials of large size, was kept beating time to a second with that in the Observatory there, with small expenditure of battery power.

A few words will explain the controlling system. Each controlled clock is complete in itself, requiring periodical winding up, and regulated approximately to time, but it is provided with a pendulum, P, constructed similar to Mr. Bain's, vibrating over a bundle, or rather two bundles, of magnetic bars, SN-NS, (Fig. 1). The normal clock is furnished with slight springs, *a*, and *b*, one on each side of the pendulum, O, which are attached, one to the copper terminal plate of battery A, and the other to the zinc terminal of battery B, the other poles, + and —, of each battery passing by the line wire

or through the earth, to one of the suspension springs of the controlled pendulum, P, thence down the rod and around the ball, R, to the second suspension spring, and by the line wire to the pendulum rod of the normal clock.

When the normal clock pendulum swings and touches the one spring, a current of one kind is transmitted from the battery, A, along the wire, producing an attraction between the one pole of the magnet bar and the wire coil of the controlled pendulum, R, the second battery, B, being meanwhile inactive, until the nomral pendulum, in its reverse swing, makes contact with the spring, B, and a current of the opposite nature is transmitted to the controlled pendulum, producing, of course, an opposite result. Thus, each second by day and night, an alternating current of positive and negative electricity is transmitted along the line, and

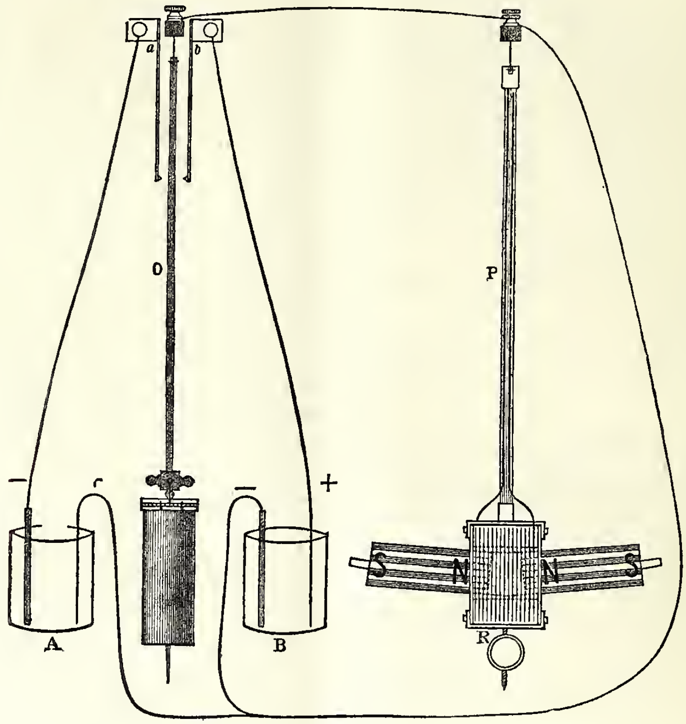


Fig. 1.

through the controlled pendulums, which most effectually secures the coincidence of beat in the normal and controlled clocks. Should the controlled clocks incline to go too slow, these correcting currents drag them onwards; if too fast then the currents retard the motion of their pendulums, and perfect coincidence of time is secured.

To show how perfect this coincidence is, I may mention, as an example, that I have noticed in the chronometer room of the Liverpool Observatory, where the director, Mr. Hartnup, has brought all arrangements regarding clocks and chronometers to a state of perfection unsurpassed even in Greenwich, that the beats of the normal clock, and of its servant or controlled clock, placed in the same room about 25 feet apart, correspond exactly about midway, so that you could only hear one beat, but approach by even two or three feet the one or the other, the separate beats were distinctly noticed. Or a still more severe test is found in the accuracy of the fire of the Edinburgh time-gun, which is caused by a mechanical pull, effected by a controlled clock standing within five feet of the gun, and exposed to all the storms of our exposed castle, with the shocks and shakes of the gun fire. The controlling clock, distant nearly a mile, is placed in the Royal Observatory on the Calton-hill, under the immediate care of the Astronomer Royal for Scotland, who, from the first, has taken the greatest interest in the subject of time and time signals, and has spared no trouble in their perfection. For upwards of four months he tested, day by day, the flash of the gun with the fall of the ball, and also with the beat of the mean-time clock, by means of telescopes and reflectors, and failed to detect any error, even to the tenth of a second. A very simple and interesting experiment may be tried by anyone standing on the North-bridge, or better still, on the Calton-hill, and holding a piece of common window glass, so that the flash of the gun may be seen through, and the fall of the ball upon the surface of the glass. After one or two attempts the ball will appear to leave the cross-trees amid the flame of the powder.

The different clocks in the observatory circuit, or rather the more public of them, report their accuracy by means of what is technically called dropped seconds. The observatory clock, by means

of the alternate contacts made by its pendulum with the springs, sends on a current every beat. Inside the clock the wire passing to the line from the pendulum rod is cut and formed into a slight spring (Fig. 2) D resting on a fixed stud, E, at all

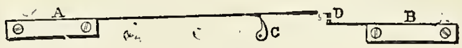


Fig. 2.

times except when a short arm, F, on the seconds wheel raises the spring, and by breaking the continuity of the wire, prevents any current passing. This happens at the 30th second, as shown by the observatory clock, and can be seen by introducing a galvanometer into any part of the line wire. In a similar way the controlled clocks are made to cut the wire at certain known seconds, and by preventing the current from passing, indicate their time on the galvanometer. Those clocks in the principal observatory circuit in Edinburgh which report themselves are, the time-gun clock, two clocks in the post-office (one in the principal hall, and the other, which fires the Dundee time-gun), a clock in the Museum of Science and Art (sympathetic), with a dial 36 inches diameter, and a clock in the University quadrangle, with a dial 54 inches diameter, and their order is as follows:—

	Seconds.
The Edinburgh Castle gun-clock cuts off the	9th & 10th
The hall clock, General Post-office, cuts off the	25th
The Observatory normal clock cuts off the	30th
The Dundee gun-clock, Edinburgh Post-office, cuts off the	35th
The Museum of Science and Art clock cuts off the	45th
The University clock cuts off the	50th

A daily record is kept of the above in the Royal Observatory.

From our experience with this system of controlling, and observing the great excess of power in the pendululum beyond what is required merely to control its vibration, we introduced, about five years ago, a system of electro sympathetic clock, which requires no winding up, and is not subject to the trips and slips inherent in former electric companions. Each clock is provided with its own pendulum, which is maintained in vibration by the alternate waves of electricity transmitted by the normal clock. The wheel-work is carried forward by a description of gravity escapement or propelment which locks the wheel, so that no force whatever can carry forward the wheel beyond the stop, and no power less than the weight of the gravity arms will drive it backwards. Fig. 3 represents a scape wheel, S, with 30 teeth, acted on by two gravity arms, A and B, one on each side. The pendulum, P, is supposed to have completed its vibration, and is returning in the direction of the arrow. The right hand arm, b, is resting on the tooth pressing it forward by its weight. The tooth, however, resting on the stop, a 2, of the left arm, A, resists its action until it is raised out of position by the vibration of the pendulum, when immediately the wheel is moved forward, till the tooth is caught by the stop, b 1, on the arm, B. being in its turn locked there till relieved by the reverse swing of the pendulum. In this arrangement it must be noticed that the hands are moved directly by the

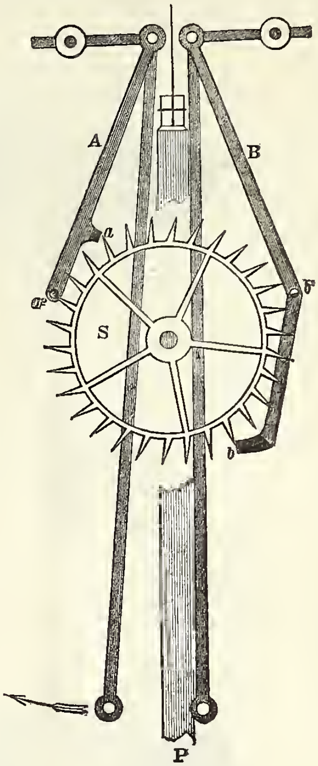


Fig. 3.

vibration of the pendulum, which, from its momentum, is able to dispense with the assistance of the electro-motive force even for 20 or 30 seconds at a time without affecting its motion, while from the power being applied at the extreme end of the lever of the pendulum rod, the smallest amount of battery power is sufficient to drive the clock. We have erected clocks on this system with dials up to 54 inches diameter, exposed to wind and weather, at a great distance from the normal clock, and wrought with perfect satisfaction. Amongst others I may mention those in the Manchester New Royal Exchange, where 10 clocks, with dials varying from 16 inches to 56, are worked in this way. In Edinburgh and Leith we have clocks of all sizes; some with dials showing seconds on a circle 16 inches diameter, and used for rating chronometers at a distance of $2\frac{1}{2}$ miles from the Royal Observatory, having the system of dropped seconds test applied to them; clocks in Glasgow, where the post-office is supplied with 10 clocks driven in this way throughout the principal public departments; in Aberdeen, Newcastle, Birmingham. And we have had the honour of exhibiting the same at the recent Exhibition of Scientific Instruments at South Kensington.

In some instances objection is taken to the introduction of a clock case so large as to take in a seconds pendulum. To meet this, we obtain a powerful arrangement by loading a simple pen-

dulum above its point of suspension, as in a metronome, and thus introduce a pendulum vibrating seconds within the diameter of its own dial. In practice, we make the balance weight above the point of suspension, a coil of wire vibrating over or around bars of magnets exactly similar to the coil forming the ball or bob, and thus nearly double the effective power. Fig. 4 represents such an

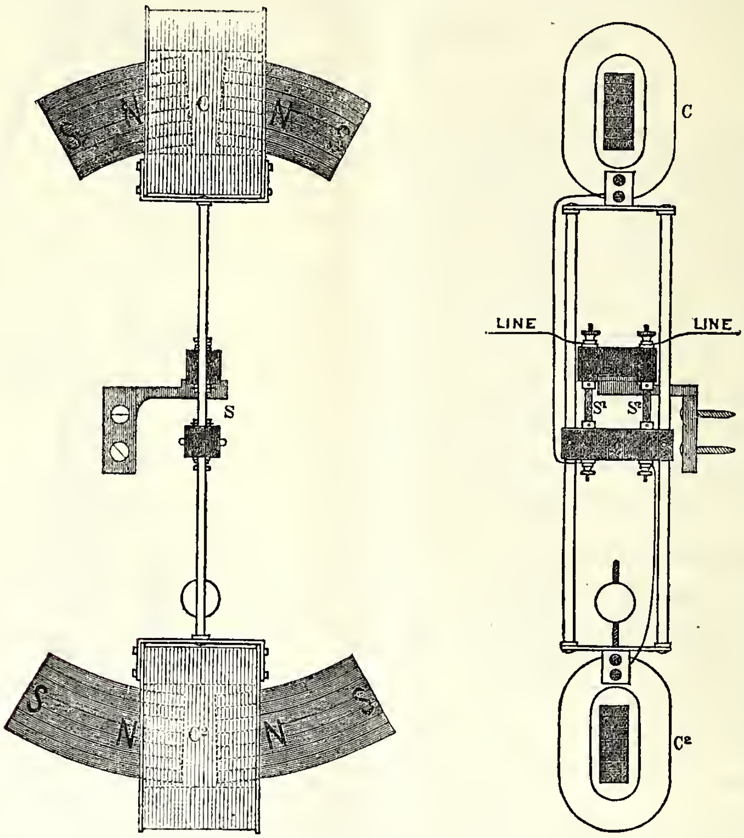


FIG. 4.

arrangement; C and C 2 being coils of wire, one above and the other below the suspension of the pendulum, and vibrating freely over the clusters of magnets, N S. The currents entering by one suspension pass through one coil to the centre, thence by the framing to the centre of the other coil, after traversing which they pass off by the second suspension to the line wire. The pendulum thus maintained in motion is applied to work the escapement or propelment.

For the past 18 years our attention has been much given to the system of reproducing the most minute divisions of time on clocks at a less or greater distance, showing not only hours and minutes, but even seconds with coincident beats with the normal clock. Latterly, however, it has been forced on our notice that really the commercial value of time is measured by minutes, and not by seconds, as for astronomical purposes. Even in our central telegraph offices only hours and minutes are recorded, to the entire exclusion of seconds. This is indeed evident from the fact that probably 99 out of every 100 clocks in use have not even a seconds hand to indicate these smaller divisions, but are provided only with hour and minute hands. The necessity and value, moreover, of some simple, effective, and inexpensive method of removing the errors, and setting to time at stated intervals such clocks as are in use in public and private offices, and even in our larger clocks at railway stations and steeples, causing them to indicate coincident time with the standard or observatory clock, and with each other, led us to consider the matter in a more general light.

I need not enlarge on the advantages which would be obtained by the general adoption of such a system, and the comfort as well as profit to the public at large, arising from all clocks indicating similar time, for this must be patent to all; but shall devote the remainder of this paper to our experience and success in accomplishing this end, and in giving an indication of what has been done by others in the same field.

About 36 years ago, the late Mr. Alexander Bain, to whom I previously referred, proposed a

method of setting the minute hands of ordinary clocks to correct time every hour in a most simple and effective manner. Whether he ever put his system into actual operation, or to what extent, I have been unable to learn, but the plan is noticed in a pamphlet published in 1843—"On the Application of the Electric Fluid to the useful Arts," and is, fortunately, illustrated by a diagram and description with references. An electro-magnet was placed behind the dial of the clock to be corrected. The armature of the magnet carried a rod ending in a fork or **V** immediately above the figure XII. A pin projecting back from the minute hand was so placed as to clear the arms of the **V** when the armature was at rest, or in its normal position, and forced to occupy the angle of the **V**, when, by the attraction of the magnet, the armature and rod were drawn upwards. Exactly at the last, or 60th second of the hour, as shown by the normal clock, contact was automatically made by it with a battery in connection with the line wire, so rendering the magnet active, and attracting the armature, and forcing the **V** against the pin in the hand, causing it to indicate the exact hour if within its range of action. The simplicity of this application must strike every one, both from its direct action and fewness of mechanical parts.

In a paper read before the Royal Scottish Society of Arts, in April, 1873, I took notice of Mr. Bain's proposed method, and this was no doubt the origin of a patent taken out by a London firm, who endeavoured to accomplish the same end, by means of a bar attached to the keeper carrying two projecting pins, which act in two slots in two other levers, from the end of which two other pins are projected through the dial, by which the minute hand is caught and forced, if sufficient power is applied to occupy the position required. Thus performing the same work as Mr. Bain did with his simple **V** moved directly by the armature of the magnet, and introducing a great amount of mechanical work, with considerable friction to be overcome before the requisite correction is applied to the clock hand, necesitating great battery power, and, consequently, increased liability of failure and expense of maintenance over that of Mr. Bain.

Another London firm introduced some even more elaborate apparatus, so as to render it applicable to larger clocks. This consists of a pair of levers acting upon the set or false minute hand of a turret clock by the shorter end. The longer end is characterised as of a zig-zag form, consisting of two inclines, which again cross each other. A long lever, provided with a heavy weight near its extremity, carries a strong pin, by which it is gradually raised during nearly the whole hour by a snail or cam upon the minute wheel arbor, the pin passing up between the zig-zig levers and opening them out. These fall again into position when the lever is raised to the top. A catch is carried by the armature of the magnet, which engages with the end of the long lever, and retains it in position when relieved by the snail about five minutes before each hour. On the arrival of the current, the catch is withdrawn, and allows the lever to fall. In its descent the pin opens up the zig-zag levers, and causes the shorter ends to strike, one at each side of the minute or set hand, as so it is supposed to force the hands to indicate coincident time with the normal clock, for which purpose the connection with the clockwork must be left sufficiently loose. Of course, the clock has to raise the weighted lever each hour, and is thus made to provide for its own correction, and supply the force to strike itself. I cannot say more than it may be ingenious, but I fear that the constant succession of blows from such an apparatus will soon tend to destroy the wheel-work of the clock.

Having been often pressed to undertake the cor-

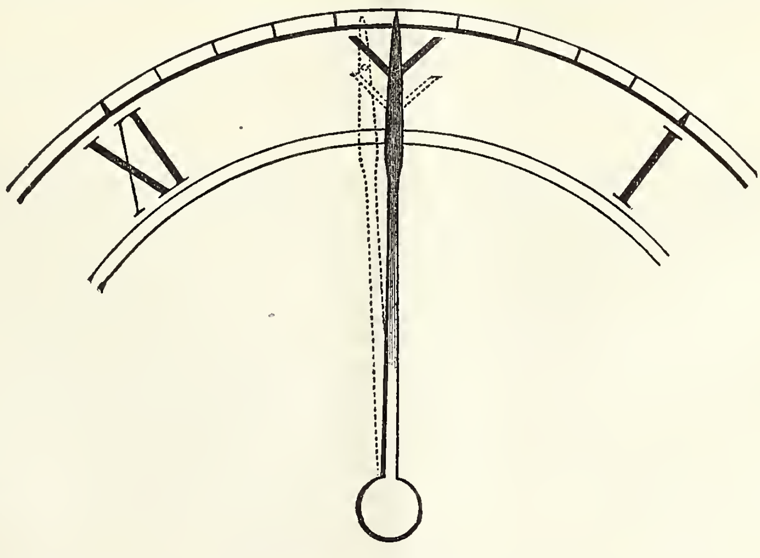


FIG. 5.

rection of ordinary clocks, and appreciating the value and advantages of supplying coincident time in office and public clocks, we resolved to adopt some system which might prove generally appli-

cable, and embody extreme simplicity in construction, and small expense in battery power, combined with certainty of action, and had several clocks fitted and under correction about the end of 1876, with an adaptation of Mr. Bain's V (Fig. 5). Instead of attaching the V directly to the armature, necessitating a corresponding amount of motion, we introduced a simple lever with the V at a greater distance from the fulcrum, thus reducing the distance of the armature from the poles of the magnet. This plan we wrought for some time, but experience showed some uncertainties in the application, placing it at a disadvantage. Nearly all the clocks to be operated upon are not provided with maintaining power-work, or, more simply, do not go while being wound, or rather the wheel-work goes backwards from the friction of the winding. To correct this error, the arms of the V must be either very obtuse in the angle, and considerable battery-power supplied; or, if more acute in the angle, have longer arms and increased motion, also requiring greater electro-motive force to work it. The most serious disadvantage, however, and this is shared by all other plans hitherto proposed or adopted, with the exception afterwards to be noticed, lay in the necessityof leaving the hand of the clock very loose in its connection with the wheel-work, to allow of its being acted on by the current. In the case of small clocks this did not so much matter, as the hands are protected by a glass, but it would prove dangerous in such clocks as are erected at railway stations, where exposure to wind must demand a more secure attachment.

To obviate these defects, we substituted the "I" or block system (Fig. 6) by removing one limb of the V, and placing the other at a smaller angle to the pin on the hand, and giving the clock a slightly gaining rate. Instead of a momentary signal or current, we adopted one of 15 seconds duration, commencing at the 59th minute 45th second of each hour, and ending at the 60th second, or the exact hour of the normal clock. The automatic break is represented in Fig. 7, where the line wire is passed by a spring, which is held out of contact with the battery terminal by means of a double lever, one end of which rests on the periphery of a disc upon the same axis as the minute hand. A notch in this disk allows the descent of the lever for a portion of a minute once an hour, during which the second lever comes into action on a disc on the scape wheel arbor. This has a step cut away for one-fourth revolution, to allow the lever to fall, and contact to be made by the spring on the stud, commencing at the 45th and ending at the 60th second, during which time a current is passed to the line.

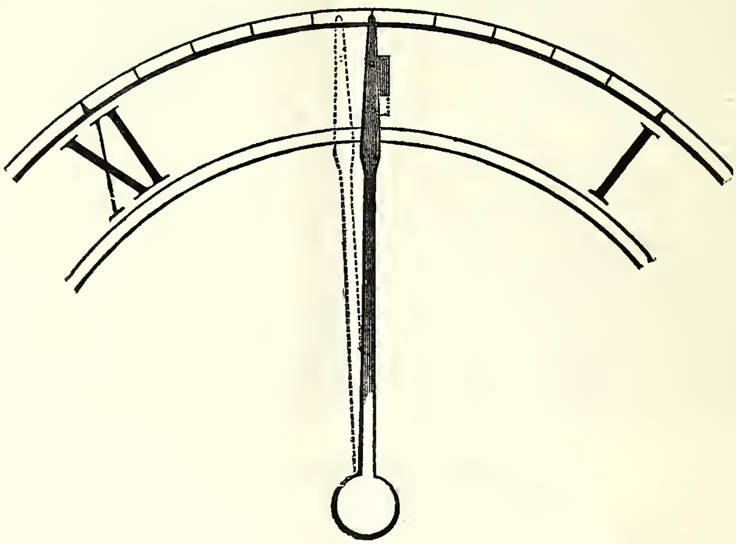


Fig. 6.

The adoption of this "I" or block system at once enabled us very materially to reduce the battery power, as the distance to be moved by the block is very small, just sufficient to take hold on the pin, and thus increasing enormously the attractive power of the magnet.

We were able also to secure the hand more firmly to the clock-work, and consequently larger clocks could be placed in circuit and treated with safety. So satisfied were we with its operation, that we issued a few circulars, offering it to merchants in Leith within a small radius, at a small annual charge; and having obtained within a few days about 30 names, at once proceeded to supply the necessary apparatus. In action, however, we encountered further difficulties, arising from various causes, such as from the hands of some clocks being very thin and light they were liable to bend, and in course of time their elasticity became so great as to overleap the block, and get out of correction. The friction, also, between the pin on the hand and the block occasionally prevented the stop from falling out of action at the cessation of the current, unless loaded beyond our wish, or placed at a greater angle than desired, in either case requiring slightly increased battery power to raise or retain the block in its position. We therefore went a step

further, and have now succeeded in obviating all these defects, rendering the principle applicable to all clocks, however large and cumbrous, having pendulums of any length and dials of any number, size, and exposure, retaining the utmost simplicity of action and lightness of mechanical parts, together with a minimum of battery power and certainty of action.

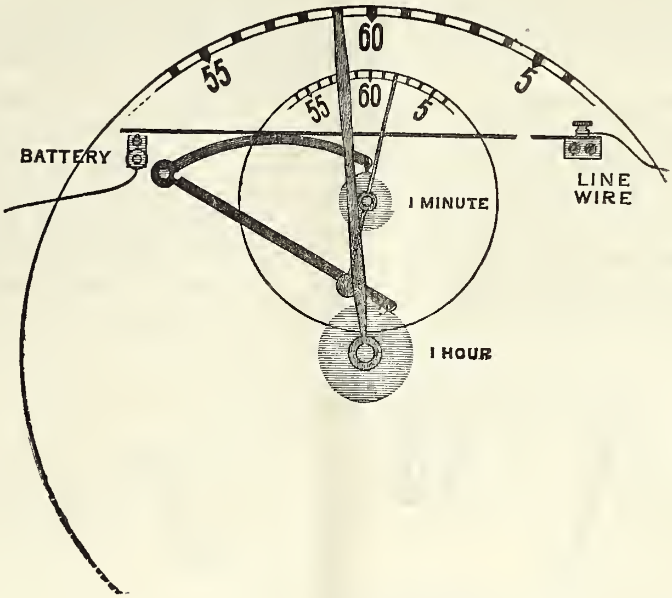


FIG. 7.

Before, however, explaining the construction of this system, I would mention a method introduced by Mr. C. V. Walker, of the late Electric Telegraph Company, and in actual operation for years in the telegraph offices of principal towns in Great Britain.

An electro-magnet within the clock case was introduced into the London circuit by a switch a minute or so before 10 a.m., each day, and being excited for about 30 seconds before 10 by a current from the London office, retained upon its armature a stop in front of an arm on the scape wheel, thereby arresting its progress until the armature was allowed to drop by the cessation of the normal clock current at the exact hour, and so adjusting the clock to within two seconds of correct time once a day.

This, arrangement, it will be seen, is only available for clocks with seconds pendulums, or for such clocks whose scape-wheels make a certain complete number of revolutions in an hour, or betwixt the intervals of correction. And for that class of clocks which indicate seconds we at once adopted the principle on the introduction of hourly currents, and have had several in action, both in Edinburgh and Leith, for many months.

I now invite your attention very shortly to the system presently worked by us, introduced last September, and to which we are gradually assimilating those clocks at first furnished with the "I" or block correction.

The clock to be operated on, as in the previous systems, is caused to gain slightly, or rather, is regulated not to lose time; the amount of gaining rate is immaterial, and may be one second in a week, or 40 minutes. The minute hand will, therefore, arrive at the hour less or more too early, and our aim is to arrest its progress to that extent. The electro-magnet (Fig. 8) A is excited 15 seconds before each hour by a current from the normal clock, and by its attractive force on the amature, B acting on the fulcrum, C, would raise the lever, D, with the stop pin at its extremity into contact with the scape wheel, S, thereby arresting its motion till the cessation of the current. A disc, M, carried by the wheel to which the minute hand is attached, here performs a most important part in the arrangement, as by it the scape wheel detent is prevented getting into action with its teeth, until the minute hand arrives at the 60th division of the dial, when a notch in the periphery of the disc, M, corresponding to that division, allows the lever, E, to pass, and along with it the other arm, D, carries its stop pin into action with the scape wheel and stops it; immediately the current is cut off by the normal clock, the magnet ceases to attract its armature, the preponderance of the levers causes them to fall out of action, and the clock is started again to go on for another hour.

Suppose, for example, the clock would gain two minutes a-day if left to its normal rate, equivalent to five seconds an hour, the action would be this: the electro-magnet, although excited at the 45th second by the governing clock, could not draw the stop into action with the scape wheel until the minute hand reached the 60th division on the dial, which it would do at the 55th second. Then the

levers, being liberated by the disc, would arrest the scape wheel, thereby stopping the clock, and retaining it till the cessation of the current at the 60th second, thus setting the clock automatically to correct time. An error of even five minutes a day could be corrected by an hourly current of 15 seconds' duration, without running any risk of stopping the clock entirely, as the momentum of the pendulum should maintain its vibration for more than that time.

The disc, M, is also useful in allowing testing of the line wire for any fault, by applying a constant current, without affecting any of the clocks in circuit, which test may continue for about 50 minutes in each hour. Thus, any fault or bad connection may be localised by a galvanometer and removed. As a constant check on the currents sent out, we introduce into each line an indicator consisting of a magnet similar in size to those used in the clocks, the armature of which moves forward a pointer one division for each current sent out upon a dial engraved in 24 hours; consequently, any fault or want of continuity in the wire or battery is early noticed.

I shall now, in conclusion, indicate some of the advantages of this system over any of the previous methods of correction:—

1st. Extreme simplicity and lightness of the mechanical parts, and anyone conversant with electricity, will at once appreciate how much depends on that.

2nd. The battery power required to work it is very small. This is obtained:—

(*a.*) From the amount of motion in the stop pin being so small, that the magnetic action on the armature is very powerful.

(*b.*) No mechanical work is demanded of the current in setting the hands of the clock.

(*c.*) No friction appears to be overcome, except that of the axis or centres on which the lever works.

(*d.*) The preponderance of the double lever over

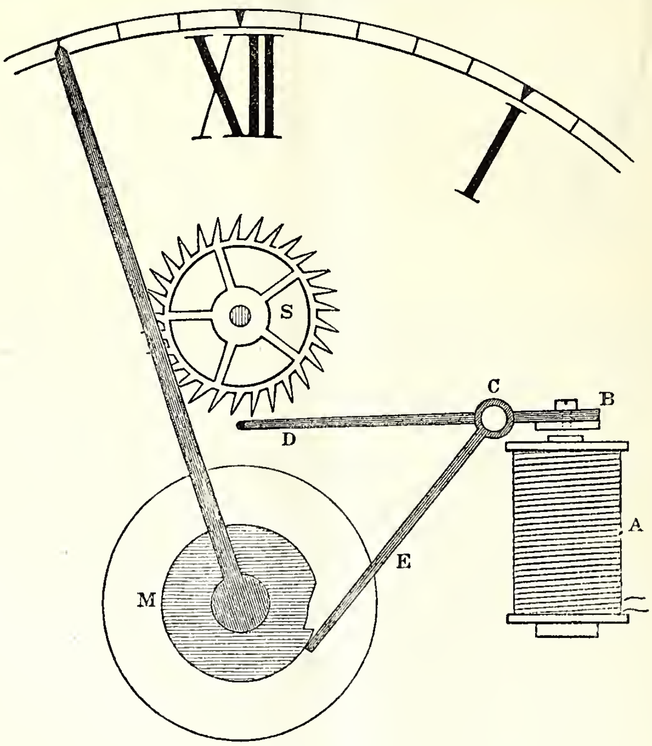


FIG. 8.

the armature is just sufficient to ensure its falling out of action, consequently no power is wasted in doing unnecessary work, or lifting useless weight.

The friction which (although it would prove very small) would be caused by the pressure of the scape wheel upon the stop pin is got rid of entirely, by taking advantage of the inclined surface, or impulse part of the pallet, to wind back the wheel by the vibration of the pendulum, and allow the lever to fall freely out of action.

3rd. The certainty of action is very great, as the forward motion of the clock is arrested at the last wheel, or the point of greatest leverage in the train, and all uncertainties of elasticity are removed.

4th. The hands may be so securely fixed as that no exposure can affect them without wholly stopping the clock.

By no other method yet suggested could correction be applied to a large steeple clock, as any interference with the hands of such would result in the destruction of the apparatus or breaking the hands.

5th. The range of action is also very great.

Should the clock be accidently set slow of correct time, it will, by its own normal gaining rate, be accelerated till the hands indicate correct time, and only then will any action be performed by the corrector. Should the clock be set fast, even to the extent of five minutes, (for the disc is cut to cover that extent of error) then the corrector could, by arresting the wheel work for the whole fifteen seconds in each hour, gradually eliminate the error, and have the clock set automatically to coincident time with the normal clock, and then resume its correcting action.

6th. It is applicable to clocks of all qualities and sizes, from the commonest German or American kitchen clock to the largest clock ever constructed, or which could be made or even conceived.

7th. The smallest possible expense in furnishing and fitting of apparatus and maintenance of battery power.

By this system any number of clocks may be connected up and kept to coincident time. Any derangement in one clock, so long as the wire connection is maintained, does not interfere with the action on other clocks in circuit. The electro-magnet, which we use for ordinary clocks, and which might with all safety be used for even steeple clocks, has only a resistance of $1\frac{1}{2}$ ohms, so that the introduction of several clocks is little felt in the circuit, while additional lines of wire can be put in operation by using a relay to repeat the signal. For steeple clocks, we, however, use a magnet of about 6 ohms, more from appearance than necessity.

On first introducing our system to the public, we proposed a visible and audible signal in addition to the automatic clock corrector, obtaining both by the motion of the "I" or block on the dial, and the sharp sound emitted by it. This we now omit, as the action is confined to the internal wheel work; but, if desired, a second magnet could be introduced, to perform the work with greater effect, and this might carry a coloured indicator on the dial, and give the signal on a bell.

Our system only corrects a clock which normally gains time, and will not affect it at all should it go slow. This, we think, cannot be looked upon as a disadvantage, as, even in the event of damage to the wire, or the temporary cessation of the current, the worst which can happen is a mistake upon the safe side of time, while it may be so little, even one second in a week, as to be quite inappreciable, and would not be known till the work was resumed. There would be no difficulty in introducing an arrangement by which the clock could be accelerated when too slow. A magnet could be so placed as to bring a slight spring into such a position that the pendulum would strike against it at each second vibration, and so cause it to move more rapidly, and the clock to gain time, its action being regulated by the disc on the minute wheel. Such, however, would complicate the system, and render it delicate and liable to derangement, consequently we would not consider its adoption advisable.

The accuracy to which clocks are set depends upon the length of their respective pendulums being measured by the double vibration as a maximum of error. Thus, a clock having a pendulum of about 10 inches long, would be set each hour to within one second of time; one with 40-inch pendulum, to within two seconds; and one with 14 ft. pendulum, to within four seconds. These amounts as a maximum would be quite inappreciable in their respective dials, so that it may be said that absolute coincidence would be indicated by all clocks in the circuit.

And why should not all clocks be adjusted in this way especially those in steeples and towers, banks, insurance, public and private offices, clubs, hospitals, schools, shops, warehouses, manufactories, and more particularly in railway stations and signal-boxes, where, for the safety of the general public, accuracy of time is so essential.

This is a matter, we think, well worthy the attention of our authorities, who, in the interest of the public, might, by correcting the existing public clocks in this way, remove to a great extent the uncertainty and annoyance consequent on their present irregularities.

Allow me, in conclusion, to express my thanks for the opportunity of bringing this subject before you, and for the patient attention accorded, but fear that I have trespassed too much on your indulgence. For this I only plead enthusiasm as my excuse. I should feel only too highly honoured if any remarks made to-night should lead, through the influence of your valuable Society, to a more general introduction of such a system into London itself, where time is of so great importance.

DISCUSSION.

Mr. Lund, as the inventor of one of the systems to which Mr. Ritchie had referred, said that anybody at all acquainted with mechanics would agree that there was a great difference between the action of the V-piece described, and that of a pair of levers acting as a mechanical finger and thumb. The strength of his brother's invention rested upon the action of such a pair of levers; and his own invention of the lever arm was intended to meet the difficulty of setting large clocks by electricity. To do that by electricity simply was, of course, quite impossible; but, on the other hand, a weight might be upheld with which the electricity would have nothing more to do than, by the withdrawal of the cam supporting it, to let it drop. Actual practice had shown that no detrimental effect whatever was produced upon the clock, and the mechanism might be arranged so that the weight would set it perfectly true. It was an axiom in all electrical matters that electricity should be used as little as possible, and that mechanical action should be used wherever it could be applied. In all self-printing telegraph instruments the electricity simply withdrew a catch, allowed the machinery to run, and the impressions were made mechanically. To use electricity for setting clocks by making the battery do it was a radically wrong principle, and the setting ought to be done by the clock for itself. The speaker proceeded to explain his own system, and said that a pin was placed upon the minute wheel, upon which the minute hand was fixed, and exactly at the hour a lever with forked pins was dropped by the current in connection with the standard clock. If there were nothing to receive the hand it might be jerked anywhere, so a little spring was placed upon the plunger, which by the action of the current was locked, the spring being released as soon as the current ceased. He had made an arrangement with a loose kind of cat's-paw, a slot and four pins in the arms at the back of the wheel; a spring action bore upon the loose lever, and at the proper moment contact was made with the centre wheel. No difference was made in the time of the clock, and the action was controlled by the arms of the centre wheel. He had in that way

arrived at a system by which electricity was made an indirect agent, but what was done was done mechanically, and could be no detriment to the clock whatever. He would be pleased to exhibit the practical working of his system at Pall-mall. One great difficulty in Mr. Ritchie's system was that a clock might lose a second or a few seconds every day, and during variations in temperature, as in hot weather, it would go on losing and losing.

Mr. Blackey pointed out that an adjusted clock would not do so.

Mr. Lund said the principle should be applicable to any kind of clock, and there was certainly the difficulty to be got over of clocks gaining and losing in that way. If that were not so, then they were all working very hard to utilise electricity when there was not the slightest necessity for it.

Mr. Blackey thought the expansion and contraction of the connecting apparatus had not been taken into consideration by Mr. Ritchie, who must know that an arm such as he had mentioned would vary to nearly the 16th of an inch. It could not, in short, be applied to the mechanism of a very fine clock, and would certainly destroy the teeth of the wheels. As to the mode of correcting errors, the seconds and minute hands could not be set together, since the former must be set to the tenth of a second. There had not been a word said by Mr. Ritchie in connection with those matters as regarded the fine construction of accurate clocks.

Mr. Botly considered the last paragraph but two of the paper of the utmost importance, and no doubt wherever correctness of time was necessary, especially on railways and in public buildings, it was of the first importance that it should be accurately recorded. He, therefore, hoped the subject would receive the attention of those authorities who could act in the matter, and felt the more strongly about it in reference to the statement in the third paragraph of the paper, that throughout the land it would lead to the introduction of Greenwich time as the standard in Great Britain, instead of each town using its local time. When senior churchwarden in his native city some 34 years ago, the town clock (which was under his superintendence) was kept by time usual in the West of England, and he had ordered it to be altered to Greenwich time. His doing so made quite a consternation in the Vestry, and the rector of the parish brought it forward at the next meeting, "That Mr. Botly had done a very illegal act in having the time of the town clock altered." But it turned out that he had done a very popular act, and he was ultimately awarded the thanks of the Vestry, the clock being thenceforward kept according to Greenwich time. That episode would show the difficulty which at one time at all events attended the alteration of local to Greenwich time. They would feel especially grateful for the paper, as it was rarely a complicated subject in mechanics was so well elucidated and explained to those not so well acquainted with it.

Mr. Dibley mentioned that Prof. Wheatstone had paid attention to the subject some time ago, and had perfected an electrical clock, which was to be found at the works of the manufacturers, who had taken over the Professor's machinery and apparatus. Professor Wheatstone had endeavoured to control adjacent clocks by means of electricity, and there was one clock particularly which had come under his own immediate observation. He would not say there were no mechanical defects in the principle adopted, not being sufficiently acquainted with its details, but would simply state that the difficulties of overcoming the mechanical and atmospheric conditions were such that the clock went in quite a erratic manner. They endeavoured very frequently to put it right, but, though they used their best efforts with it, they signally failed. From his own general observation, it was, however, totally different from the apparatus which had been so ably explained by Mr. Ritchie. It consisted of a large central clock controlling a number of others, by means of wires in the vicinity, not, certainly, putting the apparatus in connection with so large a clock as that at Westminster, which was a very ponderous piece of machinery. It was, in short, on a totally different principle. With regard to the employment of electricity in the case of particularly fine adjustments, the remarks previously made deserved very serious attention as to the expansion and contraction of the metal produced by variations in the temperature.

Mr. Blackey begged to correct Mr. Ritchie's statement of uncertainty as to Mr. Bain's use of the clip for setting the clock hand, and said that Mr. Bain had used it in St. John's-square some time before his removal to Bond-street, not in quite the same form, but still nearly alike in principle. There was no doubt, therefore, he had brought out the clip for setting the minute hand.

Professor Leone Levi, in reference to Mr. Ritchie's allusion to the ball signal on Nelson's monument on Calton-hill, said that he well remembered when, some 26 years ago, Professor Smyth being unable to find a scientific horologist who could perform the work, he (Professor Levi) suggested that Mr. Ritchie should be applied to, and from that time his friend had been connected, more or less, with all these important improvements. They were greatly indebted to Professor Smyth and to Mr. Ritchie for all that had been done in the way of the introduction of electricity to horology. The introduction of railways had given the public a great lesson in punctuality, and, in order to learn that lesson well, they must have their clocks right. At present no two clocks in London go alike, and the fact was a source of great inconvenience and trouble to all. To those who had occasion to travel much on railways and to run to stations to catch trains, a minute's difference in a clock might involve the loss of a train, and possibly hours of delay. An hour lost in these days of pressure might involve the loss of thousands of pounds. The consequences of the loss of a minute, and possibly therefore of an hour, could not be measured, and accordingly all such means for ensuring accuracy as had been suggested by one and another of those present, who were giving their attention to the question mechanically and scientifically, would be of the greatest benefit to the whole community.

Mr. Brockett could not say that Mr. Ritchie had unduly disparaged Mr. Lund's system, simply because it involved great complication. Still, a fair compromise might very well be made between the two plans, Mr. Ritchie's being adopted for turret clocks, and Mr. Lund's for ordinary time-keepers. Mr. Ritchie's system involving, as it did, the employment of very little mechanism, was more suitable for large clocks, and there was great difficulty in synchronising town clocks merely by mechanical means. He had experienced it himself as the patentee of an invention referred to by Mr. Ritchie, and his experience in that direction led him to say that Mr. Ritchie's plan would, in the end, be adopted for turret clocks, while Mr. Lund's, or some similar plan, such as his (Mr. Brockett's) own, might be adopted for ordinary clocks. Of course, the great objection to Mr. Ritchie's system, which, by the way, was the invention of a Frenchman, and at least, in principle, was patented some 16 years ago, was that the clocks were made to gain a little each hour, and the escapement wheel was arrested in its course, should it arrive at the hour too soon, so that it worked on the principle of the stop coming always in that case against the escapement wheel. It was a great objection, therefore, that the clock would be required to go too fast, as that an error in time would have to be created in order to be corrected, which seemed rather a round-about process. If a more simple method of correcting clocks could be adopted, it would be far preferable, because line wires

were liable to get broken, while if clocks were set only to gain a few seconds an hour, and the connecting line should chance to get broken, before it could be repaired. the crror would have gone beyond correction. When storms of any magnitude occur, the wires are broken in all directions, and it would frequently take a day or two before they could be repaired. During the interval the clocks would be gaining every hour, and might in a few days be five minutes out, when the correcting process would be useless. In Mr. Lund's system and his own, clocks were made to go as accurately as they possibly could, though electricity had very little to do with them, while what was done by it was done satisfactorily. To make clocks gain time in order to correct them seemed a roundabout proceeding, and the compromise he had suggested might be very fairly adopted. The small disadvantage attending Mr. Ritchie's plan might be slurred over as regarded turret clocks, and if the wircs did go wrong it would be worth while sending a man round to put them right, but it would be quite a different thing to have to send men round to every shop where such a clock might be kept whenever the wires were broken.

Mr. Coffin would merely draw the attention of horologists to the fact that it was perfectly easy to make an electric current acting for 30 seconds itself accelerate the clock, and the outcome would be, if that were done, that clocks might be made to keep perfect time. Upon the excitation of the circuit, the clock would be accelerated for a second or two, as might be desirable, just before the breakage of the current should start the clock exactly to time. Probably the great simplicity of Mr. Ritchie's latest invention could be applied in some such way, so that the current itself should produce the acceleration necessary for its action without instituting a gaining rate in the clock itself, operating in case the electric control should get out of order. Under such a system, clocks set very erroneously, fast or slow, could be gradually corrected in such a way that if very fast they could be arrested altogether for the time that the current was on, and if very slow, they could be accelerated a number of seconds each hour during the passing of the current, if the mechanism had not arrived at the point where it should be set to the correct time. He merely threw out the suggestion of electric acceleration, in order that horologists might be led to introduce it at some future day into the construction of electric clocks.

Mr. Ritchie, in replying to the remarks which had been made, was pleased to hear that the experience of Mr. Lund's system had been so favourable, and his only wish was that whatever system might be found to be the best should be adopted. With regard to Mr. Lund's observation about Mr. Bain's apparatus, he failed to see the difference between the V-piece, moving as had been pointed ont, and the movement of the levers. No doubt there was a certain amount of complication in Mr. Lund's method which the Ritchie system entirely avoided. The speaker proceeded to explain the action of the different apparatus by the diagrams. He feared that where complication of that kind existed, it might be expected that in course of time the different actions would become clogged. The principal objection to Mr. Lund's plan was that the hands of the clock must be left slack, while in the Ritchie clock the hands were made a fixture to the clock itself. In answer to the objections made to clocks being set to go fast, he did not suggest that any great amount of error should exist, but he would allow a wide limit between 1 sec. and 40. min. a week. Small clocks were not supposed to be compensating, and, as he had stated, common American and kitchen clocks could be corrected by this system, which could be introduced where people could not pay the cost of compensation mechanism, and there was no reason why the commoner description of clocks should be kept accurate, if it was possible to keep them so, and the less expensive the battery and apparatus that could be employed for the purpose the better. This system was equally successful in attaining that result in all cases, as it combined the greatest simplicity of action with the greatest amount of force. The speaker explained the action of the escapement by drawings on the blackboard, and pointed out that no damage was done to the escapement wheel by the action of the pallet against it, and asked why, if no damage was done in the recoil escapement, it should occur in the dead-beat escapement? As to the remarks made about Sir Charles Wheatstone's clock. he had himself some years previously introduced a clock upon that system. By Wheatstone's plan, the electricity was generated within the clock itself, which of course prevented its keeping anything like correct time; but for his own clock the electricity was generated by a separate apparatus altogether, and the normal clock was merely used to transmit the currents. It might be driven by a weight or by a steam-engine, but it was quite independent of the clock itself, and there was a constant flow of electricity which would regulate any number of clocks. He thanked the meeting in conclusion for their kind attention.

The Chairman, in proposing a vote of thanks to Mr. Ritchie for his paper, said it was interesting in many ways, without knowing anything about the merits of one plan or the other, to see that when such a subject was brought forward gentlemen who were rivals in the particular field should be found equally ready to criticise others' inventions, and others to give their views upon their own inventions. It was a great privilege that such discussions could be entered upon at the meetings of the Society with entire good feeling, to promote the objects they all had in view, and the meeting was, therefore, indebted both to Mr. Ritchie for his able paper, and to the gentlemen who had taken part in the discussion upon it.

Mr. G. Lund writes:—"Finding that Mr. Ritchie's excellent paper had rather exceeded the usual time, and not wishing to encroach on the time of others who might like to make some remarks upon the subject under discussion, I endeavoured to curtail what I wished to say as much as possible, which was that it seems to me, that any system by which it is proposed to use electricity as a motive power for clocks, or for controlling the oscillations of the pendulum, is open to the objection that any failure of the battery power, or corrosion of the parts of contact, causes the clocks in one case to stop and in the other an accumulated error to arise, which cannot be instantaneously made up. In either case the action is extremely delicate, and requires constant care. For all practical purposes, it seems to me, that the admirable invention of my brother, Mr. Lund, of Cornhill, is a stride immensely in the right direction. Its action is extremely simple, and from my own experience I can speak of it in the highest terms. Now, briefly as to my own efforts in the same direction. Following out his idea for a pair of levers to set the hands of the clock by the direct action of electricity, which is quite practicable in small clocks but not in large, I invented an arrangement for large church and turret clocks, in which the time current is only indirectly engaged. A weighted arm is held up by a catch, which, withdrawn by the current from the standard clock, allows the arm to fall, and this carrying a pin through a pair of crossed-legged levers sets the clock to true time. The weighted arm is re-lifted to the catch by the going or striking train of the clock, as may be found most convenient, before the next hour. My other and more recent invention is for similarly controlling small clocks by the action of a weight. It is a weighted, open-ended fork, with a locking to insure the hands being always set true, and a simple arrangement by which the fork piece is again lifted to the holding catch direct upon the main power of the clock. It is, I believe, an axiom in all matters in which electricity is used, that it should be as indirect an agent as possible, everything else being done mechanically. This is the basis of my inventions, and

forms their distinctive feature, and I hope that in the efforts now being made to insure that public and other time-keepers shall show, by means of electric currents, one uniform standard of true time, it may creditably sustain the reputation of the inventor."

MISCELLANEOUS.

NOTES ON THE PARIS EXHIBITION.

(FROM A CORRESPONDENT.)

Visitors to Paris may be glad to learn that the Government has ordered, that during the period of the existing International Museum, all formalities shall be suspended as regards admission to the Museum of Cluny and the manufactories of the Gobelins and of Sèvres; only Sundays and fête days the workshops will be closed, but the museum will remain open.

The Louvre Museum has received a munificent legacy by the late Comtesse Duchâtel, including the "Œdipe et le Sphinx and La Source," by Ingres—the original picture; two sixteenth century portraits, by Antonio Moro; and a noble Virgin, by Memling. They are exhibited, together with a portrait of the Comte Duchâtel.

The collection of national portraits is announced to open shortly on the Trocadero. It will include a number of sovereigns, heroes, famous ladies, men of law, literature, and art, from the sixteenth century down to 1830; some few curious pictures are included, such as the "Burning Bush," from Aix Cathedral, and the Morelin.

The publication of the catalogues of the International Exhibition does not proceed very rapidly; the volumes or parts of volumes issued to the 10th inst. were:—First part of vol. 1, Beaux-Arts, containing all the French and part of the foreign pictures, 2 francs; vol. 2, French Industrial Classes, 6 to 68 inclusive, 3 francs; vol. 3, French Industry, classes 69 to 90, Algeria and Colonies, 3 francs. The price originally announced was 1 franc per volume.

An acceptable arrangement has been made with respect to early admission to the Exhibition; any person desiring to visit any special class or contribution without chance of inconvenience, need only buy two franc tickets in place of one, and he will obtain admission at eight instead of ten in the morning.

Amongst the many other *on dits* flying about to-day is one to the effect that the foundations of a new English restaurant are being dug in the grounds of the Champ de Mars, and that a Chinese kitchen is about to open at which birds'-nest soup and other delicacies will be retailed; at present there is not a glass of beer or of wine, a cup of coffee nor of tea, not a bun nor a biscuit, not an ice, nor a seat to be had within the Champ de Mars building; this, especially in Paris, must read like ridiculous rhodomontade, but it is absolutely true! Ladies are in despair, and some declare they will start the fashion of bringing their sea-side camp stools; but surely such facts have only to be stated clearly to be altered.

The Parisian hotel keepers have commenced an apparently systematic increase in their charges; the Hôtel du Louvre has sent a circular to each of its visitors announcing an increase of fifty per cent. on the present rates, and the Hôtel Mongodin has at once doubled its prices.

Uniformity and moderation in prices never had such an extraordinary illustration as that furnished by the receipts of the first nine days of the Exhibition: in 1867 the price of admission for those who had no season ticket was twenty francs, but the attraction of an Imperial ceremony was also great, the consequence was that 1,602 persons paid 20 francs each, producing a total of 32,040 francs; in the opening of the present Exhibition no payment was accepted until the ceremony was all over; but from four o'clock more than eleven thousand paid a franc each for admission from the second to the seventh day inclusive. In 1867 the charge was maintained at five francs, and the number ranges from less than two thousand to not quite two thousand five hundred. On the present occasion, during the same six days, the paying visitors amounted to very nearly twenty-two thousand on the thinnest, and nearly sixty-eight thousand on the fullest day, Sunday. But the result of the nine days is still more patent. In 1867, the sum received was 118,677 francs; this year it reached 255,342 francs, more than double, while the Exhibition was visited by seven times more persons than in 1867. On Sunday last the number rose to 91,296, of whom 78,980 presented ordinary day tickets. Some French journalists arguing from the above facts, estimate that the present Exhibition will produce a total income from subscriptions at least twice that of its predecessor in the Champ de Mars.

The workmen's, or rather the master workmen's, or little masters' exhibition, is being arranged; it is on the quay near the British section.

In the same quarter the fortnightly horticultural exhibitions have commenced. The collections of roses, fruits, and vegetables are very fine; most of the glass-houses are full, and all the beds around also, with annuals and other hardy plants. The second series is announced to commence on the 16th instant, and will include rhododendrons, trained and pruned fruit trees, hot-house, green-house, and conservatory plants, hardy plants and shrubs, ligneous vegetables, forced fruits, and legumes.

PRODUCTION AND TRADE IN LAC.

Amongst the publications fostered by the Indian Product Department, there is one by Mr. J. E. O'Conor, printed at Calcutta, describing minutely the production of lac and the extensive commerce carried on in that article. Lac itself is a resinous incrustation formed on the barks of the twigs and branches of various trees by an insect commonly called the lac insect, and known to entomologists as the *Coccus lacca*, appertaining to the natural order *Hemiptera*. The incrustation formed by the insect is cellular, of a more or less deep red or orange colour, semi-transparent and hard, breaking with a crystalline fracture. The substance is mainly formed by the female insects, which generally largely outnumber the males. Each of the females inhabits a cell, and the incrustation seems intended to serve as a nidus or protection for the ovum and for the larva after it has been hatched. As soon as she is completely covered by the resinous secretion which she forms, the female lays her eggs and dies. The young, on being hatched, work their way out through the body of the mother, eating the red substance with which the body is filled, pierce the resinous incrustation, and swarm on to the bark, to which they fix themselves by insertion of the beak or proboscis, and at once commence the secretion of lac. The insects are produced in such vast quantities that the branch looks, when the young are swarming, as if it were covered with red powder, but great numbers perish either for want of nutrimont or killed by birds. The red colour of the insects is due to the substance contained in the body of the mother, on which the young feed while they are working their way out after being hatched. This substance produces the dyeing material called in commerce lac-dye.

As the insect never wanders from the branch of the tree to which it first attaches itself, and as the branch in course of time, after having afforded nourishment to millions of the insects, dries up and dies, it would seem at first sight that the ultimate extinction of the species is inevitable. But nature has provided a remedy, the insect being carried to great distances by birds and larger insects, to which, when they alight on a branch,

the *Coccus lacca* frequently attaches itself. In this manner it is propagated through a vast extent of country. Artificial propagation by man is also an easy and even well-known process. Lac is found in most of the provinces of India, and in some—Bengal, Assam, and the Central Provinces—it occurs very extensively. The best lac is generally found on the *Butea frondosa* (palus, prass, or dhak), *Ficus religiosa* (peepul), and *Schleichera trijuga* (koosum). Of the last-mentioned tree, Dr. Brandis, in his "Forest Flora of North-West and Central India," says that at Mirzapore it is stated that the lac is the best, and keeps good for 10 years, while the lac of other trees is said to last two years only. In the Central Provinces the natives say that lac from this tree is capable of being propagated on other trees, but that the koosum tree itself will not admit of the propagation of lac from trees of other kinds. It is also said to produce two crops annually, at intervals of six months, while the other lac-producing trees in the Central Provinces give only one crop. The first crop from the koosum is produced between April and June, and the second between October and December.

The goodness of lac in commercial estimation depends upon the brightness of the colour and the thickness of the incrustation; this is sometimes nearly half an inch thick, completely encircling the twig. To obtain lac in its best condition, it should be gathered before the young have eaten their way out. If the lac-gatherer delays until they have effected their exit, the colouring matter is much diminished, and the resin is pierced through at the top. There is but little dye to be obtained from the lac in this condition. As there are two evolutions of the insect in the year, so there are generally, also, two gatherings, the first being in March and the second in October. In India, lac occurs in Bengal and Assam (abundantly), the North-Western Provinces and Oudh (sparingly), the Central Provinces (abundantly), the Punjab, Bombay, Sind, and Madras (more or less sparingly), and Burma (abundantly in some places). Lac is also found in some other countries of Southern Asia, viz., Siam, Ceylon, some of the islands of the Eastern Archipelago, and China, Siamese lac being held in high estimation. In India the best lac is obtained from Assam and Burmah. In 1862, samples of lac were sent to the International Exhibition of London from Shaliabad in Bengal, from Vizagapatam, Cuttack, Raipur, Amritsar, Ahmedabad, Poona, Salem, Burma, and Mysore. The quantities produced and utilised vary greatly in different provinces, according to circumstances, certain forests being rich in lac which has hardly been touched, owing to the difficulty of access and the cost of carriage to the place of manufacture and port of shipment. In Bengal lac is produced abundantly in the jungle tracts of Beerbhoom, Chota Nagpore, and Orissa. In various places in the forests of Assam it is also found in large quantities, and forms a regular article of trade, a portion of the production being manufactured at Dacca, and the rest sent to Calcutta.

With regard to the commerce, it is stated by Mr. O'Conor that during the ten years from 1866-67 to 1875-76 the quantities of shell-lac exported to foreign countries rose from 36,653 cwt. to 80,645 cwt., being an increase of more than 120 per cent., the last year of the decade showing a specially large increase. The effect of the great demand for shell-lac, and the excessive speculation in the article, are shown in the exports for the year 1875-76. Since then, however, there has been a depression in the trade, and prices have fallen from a maximum of Rs. 97 per maund, and a minimum of Rs. 53 per maund in 1874 to a maximum of Rs. 57 and a minimum of Rs. 22 per maund in 1876. It is not probable that this depression will be of long continuance, but those who are interested in the trade might do well to take warning by the fall which has occurred, and to bear in mind not only that it is possible to overstock the market in a period of feverish excitement, but that unreasonable prices may cause consumers to turn to other sources of supply than India for their lac. The exports of stick-lac for the same period are quite insignificant as compared with those of shell-lac. The largest quantities in 1868-69 were 4,075 cwt., and the smallest in 1872-73, 115 cwt. The foreign trade in lac-dye show the largest quantities in 1869-70—20,864 cwt., and the smallest in 1874-75—8,385 cwt. The great bulk of the export trade in lac is confined to Calcutta, which is the *entrepôt* for all the shell-lac (except that which is locally used up) manufactured from the raw material supplied from the forests of Bengal, as well as those of Assam, Burma, Oudh, and the Central Provinces. Burma, however, has entered the field as a direct exporter to foreign countries, and the trade of that province will undoubtedly increase. The two largest customers for Indian lac are the United Kingdom and the United States.

CORRESPONDENCE.

DIET.

In reference to Dr. Gover's excellent paper, I would very briefly remark that, in papers on diet, the chemical views have hitherto occupied too exclusive a position. Man is a chemical compound, and an organic machine, but he is also a spiritual and a moral being. Compel a prisoner to live on a spare diet, and his spirits will decline, and his body decay; but, if the same diet be adopted from a sense of religious or moral duty, the man may have great mental and bodily strength and endurance. This is frequently illustrated by the lives of Oriental religionists.

I believe the rich in this country are much injured by over-eating and drinking, and I believe the practice too many mothers have of urging their children to eat—and especially to eat meat—beyond the instinctive desire of these children, is injurious. The all but universal decay of the teeth of children of the present generation may, I think, be attributed in part to an excessive animal diet. For this state of the teeth, oatmeal and whole-meal bread is the remedy.

With regard to whole wheat meal, which is now coming extensively into use, I would remind your readers that it requires very thorough mastication to be easily digested. There is another most important question regarding this whole-meal bread, and that is, that, being raised chiefly by the use of soda and chloric acid, it is most important that these chemicals should be perfectly pure. It has been reported to me that much injury has been done by some of these whole wheat breads, and that, on analysis, arsenic has been found, derived from the hydrochloric acid used. By drawing attention to this statement good may be done, as it is very important that pure whole wheat bread should come into extensive use. GEORGE WYLD, M.D.

12, Great Cumberland-place, Hyde-park.

USE OF ANTIMONY IN GALVANISM.

Allow me to call the attention of electricians to the use of antimony as a negative element to replace carbon in some galvanic batteries, those, for example, in which sulphuric acid or chromic acid is employed as an exciting fluid.

I have used this metal for this purpose for about five years in some batteries employed for medical purposes, and the result has been satisfactory.

Its advantages are—its cheapness; the absence of scaling or disintegration, while the broken plates always retain their commercial value, and may be melted up and re-cast; finally, galvanisation begins immediately upon immersion, which is often not the case with carbon.

The chief disadvantage of antimony is its brittleness when formed into thin plates, but this I have corrected by casting it on a core of tougher metal, such as copper, or by alloying it with a very small per-centage of some other metal. Although, perhaps, not so good a negative as carbon, the superior conductivity and other advantages of antimony may often make it a useful galvanic element. R. J. Nunn.

13th May, 1878.

NOTES ON BOOKS.

Industrial Chemistry, based upon a Translation of Payen's Precis de Chimie Industrielle. Edited by B. H. Paul, Ph.D.—London: Longmans. 1878.

The title of this book sufficiently explains its character and contents. Assuming a knowledge of chemistry in its readers, it treats of the various applications of chemistry to practical uses, and of the numerous manufactures now based on chemical processes. The general arrangement may perhaps be best shown by one or two typical examples. Sulphur may be taken as one. First, we have a note respecting its history, then one on its occurrence, *i.e.*, the state in which it is found in nature, and the localities whence it is obtained. Next its characters are described. Then follows an account of the various methods of preparation, succeeded by a short description of its uses. Its various compounds are then given, and the more important of these are treated under separate sub-heads. Sulphur di-oxide is the first, and of this we find the history, occurrence, composition, characters, preparation, uses, and compounds treated in order as with the element. Sulphurous acid, sulphur tri-oxide, sulphuric acid, sulphuretted hydrogen, and carbon bisulphide, are the other sub-heads, sulphuric acid and carbon bisulphide being of course treated at length, and the others briefly summarised.

Aluminium may be taken as a second instance. Here we have not only descriptions of the metal and its compounds, alum, &c., but accounts of the different manufactures in which the element may be considered to take an important part. Thus we find the manufacture of glass and pottery following the compounds of aluminium. It must often be a question under what head a process of manufacture may most conveniently or most suitably be classified, for instance the above manufacturing process might as naturally have been looked for among the pages given to silicon, but any questions of this sort are readily solved by a reference to the index at the end. To give any adequate description of this elaborate work within these brief limits would be impossible, but the above few lines may serve to show the extent to which it deals with each separate industrial process.

GENERAL NOTES.

Coloured Photographs.—A new method of producing coloured photographs in such a way as to give exact reproductions of original pictures, has recently been patented by Mr. J. C. Schuhmacher. The principle of the process is simply that the photograph is rendered transparent by the use of suitable varnish, after which the colours are laid on at the back. The colouring is done without any great nicety, the shades of the photograph giving the lights and shadows, and the colours of the required shades being simply applied without any attempt at artistic work at all. The reproduction of old pictures give the cracks of the varnish, even the marks of the brush, with perfect fidelity, and there appears to be no difficulty in getting the proper tints of colour. The process is also applied to portraits, &c., in which case, presumably, a little more artistic skill must be required for the choice and application of the colour. Messrs. Lombardi are now using the process, and exhibiting examples of its various applications.

NOTICES.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at eight o'clock.

May 29.—"The Late Explorations in Mycenæ, Troy, and Ephesus. By William Simpson, Esq., F.R.G.S. Illustrated by water-colour drawings, taken on the spot.

African Section.

Tuesday evenings, at Eight o'clock.

May 28.—"A Year on the Nyassa, with Notes on the Slave Trade, and on the Prospects and Means of Opening up the Surrounding Country." By H. B. Cotterill, Esq.

Cantor Lectures.

Monday Evenings, at Eight o'clock. The Third Course, for the present Session, on "Some Researches on Putrefactive Changes, and their Results in relation to the Preservation of Animal Substances." By B. W. Richardson, Esq., M.D., F.R.S. The sixth and last Lecture will be delivered on Monday, May 27.

MEETINGS FOR THE ENSUING WEEK.

Mon..... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Dr. Benjamin W. Richardson, "Some Researches on Putrefactive Changes, and their Results in Relation to the Preservation of Animal Substances." (Lecture VI.)

Royal Geographical, University of London, Burlington-gardens, W., 1 p.m. Annual Meeting.

Social Science Association, 1, Adam-street, Adelphi, W.C., 8 p.m. Mr. Heathcote H. Statham, "Artistic Improvement of the Poorer Localities of large Towns (with special reference to the East of London)."

Tues.... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (African Section.) Mr. H. B. Cotterill, "A Year on the Nyassa, with Notes on the Slave Trade, and on the Prospects and Means of Opening up the Surrounding Country."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. T. Thistleton Dyer, "Some Points in Vegetable Morphology." (Lecture V.)

Medical and Chirurgical, 53, Berners-street, Oxford-street W., 8½ p.m.

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Discussion, "Long Span Railway Bridges."

Anthropological Institution, 4, St. Martin's-place, W.C., 8 p.m. 1. Colonel Paske. "Buddhism in the British Provinces of Little Tibet." 2. Mr. Alfred Simson, "Notes on the Piojes of the Putumayo." 3. Mr. Alfred Simson, "Vocabulary of the Zaparo Language."

Wed.... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. William Simpson, "The Late Explorations in Mycenæ, Troy, and Ephesus."

Thur ... Royal Institution, Albemarle-street, W., 3 p.m. Prof. Guthrie, "Molecular Physics:—Gases." (Lecture, I.)

Fri....... Victoria Institute, (at the House of the Society of Arts), 8 p.m. Anniversary. Address by Principal Rigg.

Royal United Service Institution, Whitehall-yard, S.W., 3 p.m. Mr. W. H. Preece, "The Transmission and Reproduction of Human Speech."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Prof. Flower, "The Native Races of the Pacific Ocean."

Royal Botanic, Inner Circle, Regent's-park, N.W., 4 p.m. Professor Bentley, "Classification, Properties, and Uses of Plants. C. Divisions of the Dicotyledones:—1. Angiospermia. 2. Gymnospermia. Characters of the Gymnospermia. Sub-classes of the Angiospermia:—Thalamifloræ — Calycifloræ — Corollifloræ — Monochlamydeæ or Incompletæ (Lecture IV.)

Sat....... Royal Institution, Albemarle-street, W., 3 p.m. Prof. Henry Morley, "Richard Steele." (Lecture V.)

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,332. Vol. XXVI.

FRIDAY, MAY 31, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

CONVERSAZIONE.

The Society's *Conversazione* is fixed to take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday, the 19th June. The cards of invitation will be issued shortly.

HEALTH AND SEWAGE OF TOWNS.

At the conclusion of the Conference on this subject, the following resolutions were passed:—

I.

"That this Conference desires to record its opinion that further legislation is needed, especially with regard to the constitution of County Boards, with a view to strengthening the local government administration; and authorises its Chairman, in conjunction with the Council of this Society, to bring the matter before her Majesty's Government in such manner as he and the Council may deem to be most expedient."

II.

"That, in the opinion of this Conference, the benefit to large towns of a well-devised and effective system of sewers is very often entirely neutralised by the careless and improper way in which the house drains in connection with such sewers are laid, and connected with the soil and waste pipes of the house."

III.

"That all drains intended to be connected with the sewers of a sanitary authority ought to be made by such authority (in the same way that house services are made by gas and water companies to their mains)."

IV.

"That powers as extensive as those contained in the 11 and 12 Vic., cap. 112, with corresponding duties, should be conferred and imposed upon all local sanitary authorities, including those in the Metropolis."

V.

"That the Society of Arts be requested to urge these views upon the President of the Local Government Board, by deputation or otherwise."

A full report of the discussion will be given in a forthcoming number of the *Journal*.

CHEMICAL SECTION.

Thursday, May 23rd, 1878; Dr. J. H. GLADSTONE, F.R.S., in the chair.

The paper read was:—

THE POSITION OF SCIENTIFIC CHEMISTRY IN A SYSTEM OF TECHNICAL EDUCATION, AS ILLUSTRATED BY SOME OF ITS APPLICATIONS.

By John M. Thomson, F.C.S.
(King's College, London.)

In commencing my remarks I may explain that, when some time ago I was requested to appear before you, I committed myself somewhat inconsiderately to a title for my paper which may appear to others, as on reflection it does to myself, too ambitious and comprehensive. My original intention in fact was only to describe a few of the more striking illustrations of the relation between chemical science and technology, as derived from some of the best known industrial processes. But as I proceeded, I found that some reference to the more general views connected with the subject could scarcely be avoided.

It is, however, with great diffidence that I venture upon such general remarks, as I am quite sensible that a wider experience than mine, and a much longer time than is now at my disposal, would be requisite to do justice to the large and important questions suggested by the title under which my paper appears.

In endeavouring to form an opinion as to the position which scientific chemistry in general should hold in a system of technical education, the considerations involved present themselves mainly under two heads, viz., first, the nature and differences of scientific and technical work, and second, the circumstances of the persons who may be engaged in them.

First, as regards the distinction between scientific and technical work, I will for the present assume, that in the former there is necessarily a constant activity of the intelligence; while the latter, considered merely as work, consists of strictly manual operations, and, however dependent it may be on scientific invention for the suggestion of its methods and the production of its materials, does not necessarily involve any mental process.

Second, as regards the circumstances of the persons engaged in scientific and technical work, we may also for the present consider them as being entirely different; for we will suppose that those whose work is scientific are engaged in and are preparing for a profession, while the others, whose work is entirely technical, are for the time to earn their livelihood by the labour of their hands.

The one set of persons devote themselves during a considerable time to an elaborate course of preparatory mental training and scientific study, with the view of acquiring the knowledge and inventive skill, by which they are afterwards, with intellectual labour, to conduct scientific research and promote the advancment of scientific discovery, whether in its theoretical aspects or in its practical results.

The others, who are to live by their manual labour, must of necessity devote themselves from a much earlier age to the work of the factory,

and forego the advantages of a regular or systematic education in its higher branches; quite independently of any circumstances arising from their social position.

If the distinction thus broadly drawn between scientific and technical work, and the circumstances of the persons engaged in each, carried along with it the settlement of the subsidiary questions connected with the subject, we should at once draw the inference that the education required for the two kinds of work must be entirely distinct. Some indeed go so far as to hold this view; while others, fully admitting the difference in the nature of the actual work in the two instances, are inclined to believe that there is great similarity in the kind of education which should form the preparation for each. It is probable that the truth will be found between these two extreme opinions, and that the main difficulty to be encountered lies not so much in determining the nature of the education respectively required for each, as in the discovery of the best means of following out a practical system of education, more especially that of a technical kind. It is unnecessary for me here to advert to the requirements for purely scientific education, as I believe that these are now sufficiently well understood in this country, and little difference of opinion, at least among scientific men, exists in regard to them. It will be generally acknowledged, I presume, that our Universities and Colleges already furnish, or ought to supply, all that is necessary for the fulfilment of a scientific education. It is well known, however, that through circumstances, upon which it is unnecessary for me to enlarge, many of the Universities are far from affording the means of scientific instruction, which should be found in the national educational institutions of a country whose prosperity is so intimately connected with the progress of scientific knowledge; and it cannot be doubted that there is an urgent call upon the University authorities, in the direction so well indicated by the report of the recent scientific commission, to accord to science in all its branches a more prominent and advantageous position in the higher education of the country than it at present possesses. The same remark applies in some measure to our secondary schools, in which as yet only a partial recognition of the requirements of instruction in science has been effected; but we may hope that the progress of opinion in the country is now such that ere long science courses, both of a systematic and practical nature will form a regular and important part of every school organisation. Indeed, there is strong reason for the introduction of elementary scientific teaching even into the primary schools of the country, seeing that so many persons proceed directly from these to be engaged in the business of their lives.

As regards an education for technical work strictly so called, it is obvious that the factory or workshop is the proper field for the acquisition of all the manual dexterity and knowledge of mechanical and other details which are required for its successful application to industrial processes; and, so far, the first and main question to be considered, in the interest of the workman himself, as well as of the industry to which his labour contributes, is how that manual labour can be executed most perfectly and most profitably.

We will suppose that, under the advantages recently acquired from the Education Act, all the common workmen, of whatever class, shall have had the benefit of the elements of a general education before they pass, at the age of 13 or 14 years, to their mechanical pursuits. At first sight, therefore, it would appear to be mainly necessary to secure healthy and willing operatives, whose senses and muscular power have, by natural capacity and artificial training, been brought to the highest degree of mechanical skill. It is apparent that, to secure these conditions, workmen must be selected of the best physical organisation, and that they must be initiated into their work at such an age as will command all the advantage of the adaptive stage of growth and development in their bodily frame—physiological conditions which would clearly be frustrated by filling up with other occupations, or attempts at a more general education, those years in which alone mechanical skill and dexterity can be attained.

But, while a certain part of the general or intellectual education which is adapted to those who are to follow scientific pursuits must, in the case of the workman, be sacrificed to the attainment of that physical cultivation which is immediately necessary to the perfection of the industrial arts, it becomes all the more necessary that ample provision should be made for supplementary education, of such a kind as will contribute to the social improvement of the artisans as a class; and, more especially, will place within the reach of those of them who are capable of the higher development of their powers, the means, not only of improving their mechanical skill, but, possibly, of raising them into a higher position, and enabling them to become in their turn the improvers of old or the inventors of new processes, based upon scientific knowledge.

In order to appreciate the nature of the education best adapted to the artisan, and the real distinction between that and scientific study, it will be proper to consider shortly the relation subsisting between the progress of the arts and the advancement of scientific discovery. The slightest retrospect on that progress shows how the prodigious extension of the industrial arts, constituting almost their origin, in the middle of the last century, was coeval with the introduction of more accurate methods of investigation in modern science, and how closely ever since that time the advance of manufacturing industries in this country and elsewhere has followed the greatest achievements of scientific discovery. Confining myself more particularly to the chemical aspect of the subject, I may say, that although the alchemists, by their great labour and patient industry, had subjected a vast number of bodies to investigation, still, unfortunately for us, their labours were in the main fruitless, in consequence of their mistaken ideas of the nature of the bodies with which they operated. It thus fell to the lot of Boyle and Stahl, the latter especially—by his phlogistic theory—to lay the foundation of true scientific chemistry. Following these, the names of Black, Cavendish, Lavoisier, Dalton, and many others will occur to all. But we cannot over estimate the value to be attached in this progress to the researches which led the latter chemist to mature the theory of definite combining propor-

tions, and to the work of Wollaston, Berzelius, and Thomas Thomson, by which that theory became of real practical importance, not only in scientific chemistry, but also in its application to the arts. Looking back upon the period to which I have just referred, it is difficult for us, with our present extended knowledge of the science, to realise the state of ignorance which prevailed with respect to the nature and constitution of bodies. We have only to remember that at that time not more than about three-fourths of the elementary bodies now known had been discovered, and an inconceivable quantity of compounds, both mineral and organic, were wholly unknown; that hydrogen was only discovered by Cavendish in 1756, oxygen by Priestley in 1774, chlorine by Scheele in the same year, the formation of water by combustion of hydrogen by Cavendish in 1784, and by Watt; iodine by Courtois in 1811, and bromine by Ballard in 1826.

A hundred years ago the true nature of alkalies and earths was still a mystery, and they were regarded as elementary bodies. Baryta was just then discovered, and in 1807, Sir Humphrey Davy first obtained metallic potassium and sodium. The chemistry of organic bodies had no existence, the whole history of fermentation was unknown, and the chemical nature of fats, with the true theory of saponification, was only given by Chevreul in 1811. Contrast with this the present state of our chemical knowledge both in its theoretical and practical aspects. Not to mention the hundreds of instances in which chemical research has led to the discovery and improvement of substances used in the mechanical arts, I need only call to your recollection, as examples of the application of scientific discovery to the first suggestion and subsequent extension of practical chemical processes, the whole arts of dyeing and calico-printing, as well as that of bleaching, the manufacture of sulphuric acid, alkali, and soap, the knowledge of the nature of fermentation with its application to the arts of brewing and distillation, sugar refinement, and the reduction of metals from their ores, the processes for artificial lighting, together with the whole application of chemical knowledge to agriculture, medicine, and sanitary purposes.

Previous to the present century, chemical analysis, in so far as it could be said to exist, was only qualitative. Its growth into quantitative analysis became possible only after the establishment of the theory of definite proportions, or, as it came to be called, atomic equivalents, between 1820 and 1830; so that the whole of the minute knowledge which we now possess of the constitution of bodies, with all the wonderful results that have flowed from it in initiating and stimulating the chemical industries of this country, has mainly sprung from the researches of scientific chemists within the last sixty years, and, as has been well remarked by Professor Odling, there is now scarcely a material in common use which is not the product of a refined chemical process, or at least has been subjected to some chemical change.

In choosing the particular instances by which to illustrate the advantages which have accrued to chemical manufacturing processes through the application of strictly scientific principles, we are met at once with the difficulty of choosing such instances as will appear equally good to all. I have, therefore, endeavoured to select those cases which appeared to me to present this application with the greatest quickness and simplicity. I must apologise also to those who are trained chemists in bringing before them matters with which they are, no doubt, already familiar, but I will endeavour, in my remarks, to deal as closely as possible with those parts of the processes which pertain to the object I have in view, without mentioning, unless when absolutely necessary, mechanical arrangements and details.

The cases which, if time permitted, I should have liked to bring under your notice, are taken from three industries of the country which I think may fairly be held to represent in a great degree the useful application of scientific principles to practice.

These are:—

(1.) The alkali manufacture.
(2.) Manufacture of dyes.
(3.) Reduction of metals from their ores.

[Mr. Thomson then proceeded to give a description of the following chemical processes, pointing out in them those points in which modifications or improvements had been arrived at by the application of scientific reasoning; some of them being illustrated by experiments.

In the alkali manufacture the following instances were taken:—

The production of sulphuric acid by the oxidation of sulphur dioxide by nitric peroxide, steam, and air. The direct conversion of common salt into sulphate of soda by Mr. Hargreave's modification of the first part of Leblanc's process, namely, by the oxidation of sodium chloride by a regulated amount of steam and air according to the reaction,

$$2\,NaCl + SO_2 + O + H_2O = Na_2SO_4 + 2\,HCl.$$

In the second part of the alkali process (the reduction of sulphate into carbonate) reference was made to the researches of Dumas, Gossage, Dubrunfaut, Kopp, and others in the direction of elucidating the more remote actions going on in the balling furnace.

Allusion was then made to the recovery of manganese from the waste chlorine liquors employed in the manufacture of bleaching powder; and a short description of the reactions employed in the Dunlop process, with the modifications and improvements suggested and carried out by Mr. Weldon, was given. In connection with the recovery of waste material in the alkali manufacture, Mond's process for the recovery of sulphur, and Mactear's modification, more especially applicable to the drainage from waste heaps, were shortly described. A short account of the so-called ammonia process of manufacturing sodium bicarbonate by the action of carbon dioxide on brine saturated with ammonia, taking advantage of the following decomposition,

$$NaCl + NH_3 + CO_2 + H_2O = NaHCO_3 + NH_4Cl$$

was then given; and allusion made to Mr. Weldon's proposal for using magnesia instead of lime in the recovery of the ammonia, and so obtaining the MgO again for further use, by decomposing the magnesium chloride with air and steam.

Passing from the consideration of the alkali manufacture to the production of dyes, allusion was made to the work of Faraday and Mitscherlich,

with regard to the discovery and determination of the composition of benzol, from which has arisen gradually the manufacture of aniline.

After describing shortly certain points resulting from the work of Hofmann on the molecular constitution of volatile organic bodies; the investigations of Graebe and Lieberman, Perkin, Anderson, and others, on the artificial formation of anthracene and alizarine, was then pointed out, and a synopsis of the synthetical formation of alizarine was given.

Time not permitting any further special illustrations, Mr. Thomson proceeded.]

No one who has any acquaintance with the special industries now referred to, and the other great works of a chemical and mechanical kind for which this country has been justly famous, can doubt the prodigious importance which they possess in relation to the commercial prosperity of the country, or the necessity which exists for maintaining them in the highest possible state of efficiency and perfection.

But circumstances have of late arisen which indicate that we may not always maintain that supremacy in the industrial arts which has been the cause not less of pride than of profit to this country; and already there is good reason to believe that an urgent necessity has arisen for measures being taken to prevent our being outstripped by other nations in the competition for superiority in manufactured products.

The coincidence of an advance in the excellence of quality, artistic taste, and greater cheapness of foreign manufactures, with the establishment of important public technical schools in many parts of France, Germany, Belgium, and Switzerland, and the undoubted fact that great pains have been taken in these countries to improve the education of workmen in the principles of science and art, have awakened the attention not only of men of science, but of the manufacturers in this country, to the condition of British industries as regards the education of those employed, and have clearly proved the urgent necessity for an effort being made to place our artisans in as favourable a position for the improvement of their practical skill, by increased artistic and scientific cultivation, as that which has been shown to be producing such important results among some of the continental nations.

The older prejudices with respect to the general education of the masses, and the conservative feeling in favour of long established methods of instruction, which have for long obstructed the march of improvement in this country, are now yielding to the more pressing fear of injury to its material welfare, and the opinion gains ground every day that the British workman must be educated to as high a point as possible in his craft, in order that he may hold his ground in competition with those of other countries. The principal difficulties therefore which present themselves are to determine the exact nature and method of the education which is most suitable, and to obtain substantial means of carrying it into effect.

Now, if the close relation between the progress of scientific knowledge and its practical application, to which I have referred, be well ascertained, it must be obvious that, to maintain our superiority in the useful arts, it is essential that those engaged in them should have within their reach the means of studying their highest development, by acquiring a knowledge both of the scientific principles upon which they are founded, and of the practical details which lead to their most successful results.

If the Government cannot be persuaded to move in this work, the public must take its place; and we hail with satisfaction the promise which has already been made of its commencement, by the movement which has been set on foot among the great City Companies of London, for devoting a large sum of money to the promotion of technical education. May we hope that wisdom, equal to the liberality of the donors, may be shown in the application of the funds, in such a manner as to give a strong general and permanent stimulus to the advance of our industries, through the improved education of the working classes.

The education contemplated under any new scheme should be of such a nature, and placed in such conditions, that it will be readily available to all who have the desire or capacity to take advantage of it, and more especially to the better informed or upper workmen and foremen of great works; while, at the same time, the arrangements of the factories should be such that they not only throw no impediment in the way of, but facilitate to the highest degree possible, the attendance on such instructions, of all who can in any way profit by them.

Acknowledging, as I do, to the full extent, the great value of the efforts which have been made from time to time in many of the seats of our great manufacturing industries to provide instruction specially adapted for the artisan class, I think that it is sufficiently obvious that a much greater and more combined effort requires still to be made to meet the present exigencies of the case; and that, for the accomplishment of this object, partly by the adaptation of already existing institutions, and partly by the foundation of new schools, a regular and complete system of technical education shall be established throughout the country.

In how far it may be necessary or expedient to place such schools under the general regulation of a central university is a question which I do not feel myself competent to discuss; but that the schools or means of education must be generally distributed, so as to be brought conveniently within the reach of all, seems to be obvious, from the great difficulties which most workmen experience in availing themselves of the means of instruction, even when placed comparatively within their reach.

That education in the principles of science, given in the most simple and approved way, but equally correct and valuable with that which is offered to the strictly scientific student, should form the foundation of all technical study, will be readily admitted; and we shall suppose that under an improved school system such education may have been begun at school, or has been obtained before the commencement of strictly technical study. It is only further to be observed that, in case of that elementary knowledge not having been obtained before the commencement of work, it will be necessary to provide for it in the newly-founded technical or workmen's colleges.

The selection of the topics for further in-

struction in a system of technical education is a matter of somewhat greater difficulty, from the very wide range covered by these branches. This difficulty, however, partly disappears, when we consider that it is not the details of the arts themselves which should be attempted to be taught, but mainly the general principles and methods involved in the technical processes. This is especially the case with regard to chemical technology, in which, while it may be admitted that the details of some of the more important processes will render it necessary to arrange for their special study, it must be obvious that a certain number of chemical facts and principles are applicable to a variety of analogous processes, and that, on the ground merely of economy of time, it would be inexpedient that they should be repeated under each; while the attempt to teach the individual processes would involve a multiplication of courses of instruction, incompatible with any possible system of technical education. It becomes, in fact, more and more apparent, the more attention we give to the subject, that, with the exception of some special details which belong to the management of particular processes, the whole of the instruction required in technical chemistry is essentially of a scientific character.

It is therefore in the choice of the topics rather than in the nature of the instruction that the distinction between scientific and technical chemistry consists; and there can be little doubt that, while the practical applications or special subjects are kept clearly in view, the more purely scientific and more generally applicable the instruction is, the better will it be both for the more immediate advantage of the special branch of industry, and for its wider influence on the progress of general technical improvement. Some difficulty may no doubt be felt as to the extent to which this education may with advantage be carried. Without disputing the general proposition that a workman executes his work more easily and perfectly in proportion to his knowledge, or wishing to undervalue in the slightest the incalculable advantages to themselves, and to the community at large, which may be expected to result from an improved education of the working class, it is obviously necessary in connection with the more immediate consideration of the influence of scientific knowledge upon the excellence of the works produced by our national industries, to distinguish between that kind of manual labour, which is a mere mechanical exercise of muscular force, and that sort of work which involves more or less thought or skill in its performance. In the first case, or that of the unskilled labourer, it must be acknowledged that the mechanical operations, which form the daily occupations of a large proportion of our workmen, are of so simple and monotonous a kind as not to admit of direct improvement by invention or thought. But for those whose operations are susceptible of variation or improvement, and more especially for the skilled artisan, the advantage of a superior education, increasing his general intelligence, making him acquainted with the scientific principles of his art, and giving him the means of suggesting improvements in technical processes, cannot be over-rated.

The great object therefore in technical education should be, not to attempt the higher education of all workmen, but to make it possible for and to encourage specially those whose ability and circumstances render them capable of a higher cultivation, and of acquiring such a superior knowledge of principles and practical details as may enable them to rise in their social position, to influence others by their example, and to increase the amount of productive skill employed in the manufactures of the country.

For the foremen and managers, especially of great works, occupying as they do a most responsible and important position as regards the whole body of men over whom they may be placed, special provision should be made, and it would even be desirable that a greater amount of preliminary preparation, and more efficient means of continued cultivation could be devised to give them the varied qualities of tact, judgment, scientific knowledge, and practical skill, which may be available for good in their position.

It would lead me far beyond the limits which I have prescribed to myself in appearing here tonight, were I to attempt now to sketch out a system of technical education such as might appear desirable in the present position of the country. Indeed, it would be superfluous for me to do so, as I may refer with confidence to much that has been recently written on the subject, and more particularly to the programme for examinations issued by this Society, to Mr. Samuelson's able paper at the meeting of the Social Science Association at Glasgow in 1874, to Professor Huxley's lecture, and to Colonel Donnelly's letter to Sir Sydney Waterlow on the constitution of a technical university, in all of which chemistry is made to form an important part of technical education.

It now, therefore, only remains for me, in conclusion—applying the foregoing remarks on the relation of scientific and technical work—to revert shortly, as proposed in the title of my paper, to the proper place of scientific chemistry in a system of technical education.

Assuming, as I have done, that all technical work in chemistry has had its foundation in scientific knowledge, it is obvious that a thorough acquaintance with the principles of chemical science must be the groundwork of all subsequent study, however special it may be in its application. The study of these principles in their simplest form, ought, if possible, to constitute a part of elementary education in the primary schools, and at all events it should take an important place in the secondary schools, as well as in the universities and colleges.

There can be little doubt that it would be on the whole preferable that the acquisition of this knowledge of principles should be made before the young person is wholly engaged in the business of his trade. But as it cannot be expected that for a long time the educational system of the country will be such as to procure the result mentioned, and it is certain that many of the artisans must trust to an education which is continued on into their adult life, there is an obvious necessity for special arrangements to provide that education without interference with their industrial occupations. I am of opinion, therefore, that whatever else may be attempted in technical colleges or mechanics' institutions, there must still be in them also some provision for instruction in scientific principles, to meet the case of those who have

not had an opportunity of previously obtaining it.

With reference to such courses of instruction in systematic chemistry, however, I would remark that, from the attempt in these, as generally conducted hitherto, to embrace the whole range of chemistry, they are apt to be too much encumbered with special technical details. It is impossible in such courses, on the one hand, to do justice to the description of technical subjects, and it is certain, on the other, that the systematic teaching of principles suffers from the attempt to include too many subjects within its bounds. It appears to me, therefore, that, whether in the universities or elsewhere, there would be a great improvement in the system of chemical instruction, if, instead of attempting, as is too often done, to embrace the whole range of chemistry in one course, preliminary courses were delivered, in which no more than instruction in the principles of the science was undertaken. With respect to such systematic courses, I am of opinion that they —as, indeed, all other instruction in sciences founded on observation and experiment—should be eminently practical in their nature; but this need not deprive them of their elementary character, nor prevent them from consisting mainly of the inculcation of principles of universal application, rather than of special facts, the study of which will come more appropriately at a different time, and in a different form.

In the next place, admitting fully, as I do, the necessity for special provision for education in chemistry applied to the arts, and that a variety of courses in applied chemistry must therefore be instituted, I am not disposed to admit that the mode of instruction in such courses is different from that which is applicable to the science in general, excepting in so far as arises from the necessity for selection of the topics in such a manner as to bring the teaching to bear in the most useful manner on the industries which are of greatest value and importance.

The teaching, while practical, must be equally scientific, the methods of analysis must have all the exactness which belongs to the highest science, and must be as generally applicable, in so far as they form part of general courses of instruction, while minuter details of manipulation and treatment must be left to be learned in the works or factories themselves.

Scientific chemistry, therefore, holds a legitimate and important place in any system of technical education, even while the subjects which are taught may be of special application, and there can be little doubt that the more thoroughly scientific and systematic the teaching of our technical education is made, the more efficiently will it contribute to that advancement in the chemical arts which has formed, and will continue to form, so important a part of the manufacturing industry of this country.

DISCUSSION.

Mr. H. T. Wood, in opening the discussion at the invitation of the Chairman, said he thought he could not do better than draw the attention of the Section to a paper which he had received that morning, the contents of which were probably known to many of the audience from a leader in the *Times* newspaper of that day. It was the report of the Executive Committee of the London Guilds, appointed to consider the best means for establishing an institution in London for the promotion of technical education. It had been his duty, at the invitation of the committee, to draw up a report on the subject. That report, with others, had been duly considered, and the result was the scheme just put forward by the City Committee, a scheme he could not but regard as holding out great promise of a most successful future. To him, at least, it appeared that the committee had acted most wisely in rejecting the system followed in many of the great Continental schools—endeavouring to teach workmen the practical part of their employment. The want of English artisans was not a want of handicraft skill, but of scientific knowledge. Practical dexterity might well be left to be acquired in the workshop, if once a knowledge of principles had been instilled. Experimental workshops, he felt convinced, were a mistake, and he thought the committee might sincerely be congratulated on having recognised this fact, and so avoided the temptation of endeavouring to be too purely practical. He then gave a brief summary of the report, which proposed to establish a central institute, with professors of applied science, and to assist local effort in establishing technical schools. He might just note that it would not be entirely easy to draw the line which marked off applied science. The pure science of to-day was the applied science of to-morrow, and day by day we were adding to the number of the applications of science. Nor could we parcel out any science into its applications to separate trades. There was not a chemistry for dyers and another for workers in metal, nor could either trade confine itself to that department of science which specially dealt with its own subject-matter. The student must first learn the principles of the science thoroughly, and not till he had done this could he safely turn to any one branch of it. These considerations had evidently been kept in mind by the committee of the guilds, and the result had been the very practical and workable scheme just published. In concluding, he wished to express his thanks to Mr. Owen Roberts, to whose unwearied energy was mainly due the success thus far of the City scheme, and to whose courtesy he was indebted for a copy of the report and for permission to use it that evening.

Mr. Matthieu Williams, while concurring with all that had been said as to the necessity of technical education, thought we ought to be very careful in teaching working men to avoid the tendency which had considerably developed of late, and was seen in many of our elementary teachers, of making the mistake as to what efficiency really meant. Take, for example, a subject like that which had been illustrated before them—the idea of chemistry which was presented to the mind of a chemical expert. He naturally and necessarily regarded those subjects under investigation, and which constitute the difficulties of the science, as the profoundest part of the science. This was a great mistake. That was the superficial part. That was the outside, the boundaries of which they were gradually increasing. But the most profound of any branch of science were those portions which were most thoroughly established and generally were the simplest. The properties of oxygen were amongst the most profound in chemistry, the law of gravitation the most profound generalisation of physical science, and yet these were most simple. In teaching they must endeavour to avoid throwing too much forward those special subjects which particularly interest the expert. To illustrate this, 20 years ago, when the Midland Instituto—which had been most successful—began, he had conducted three classes there entirely for working men. They came of an evening, and the classes were physics, chemistry, and physiology. It was desired and expected by the committee that he should teach physics mathematically, as it would be taught in the universities. Having had some experience

be felt convinced if he did, he should close the institute' and, therefore, he disobeyed the orders of the committee to some extent; and instead of that he taught the subject as a matter of fact mainly, and so that it was well within the reach of the students, and by drawing all his illustrations from matter familiar to them, and taking the practical and experimental rather than the abstruse, he was able to keep his class going, and ultimately brought them up to the higher level. The difficulty was not so great in chemistry as in physics. The part of chemistry they must be very careful with was the molecular portion; and to illustrate his meaning, he was looking at his old text-book which he studied 40 years ago when he was an apprentice—"Henry's Chemistry." Looking at that book, and comparing it with the modern text-book which his son was now studying, he almost felt pity for him in some respects, although, of course, he had very great advantages in other respects. The extreme simplicity of the book was remarkable. The direct teaching of the facts is at once commenced, leaving the theory to be given a good deal later. There were the facts and the generalisations. The old-fashioned method was by beginning with the properties of oxygen and hydrogen, taking compounds of these two, working two or three together, and accompanying them with experiments; and thus making the subject quite fascinating, and giving also a directly practical bearing to it. They must remember that in all their dealings they had not got poople whom they could compel to learn. First, they must begin with science, and then proceed to the practical application of what they were teaching, otherwise they would begin with large classes, which would gradually dwindle down, at the end, to two or three students. They must not fall into the error of beginning with too much. Let them teach the facts first, and the theory afterwards. As to the instruction of apprentices, be could speak feelingly on that point. He had served for seven years, with hours from six in the morning till eight in the evening, and after that time he managed to get a considerable amount of scientific education. The great difficulty they had to contend with was the long hours. The apprentice was the most important person to educate. He had seven or eight years of apprenticeship, and if he were simply a muscular machine his brain would fall into something like torpor, and the difficulty of arousing it afterwards was very considerable. Our system of apprenticeship was not a good one, and was too often a delusion, the only person profiting by it being the master, who obtained a large premium with the apprentice. Speaking of the benefits conferred by the development of science, he said they must remember the fact that there was a time when scientific men needed the teaching of the artisan. The method by which all our great achievements had been gained was the workshop. The practical method alone was followed by workmen, while learned men were following their disquisitions, but doing nothing. Technical education taught us how to carry out the metbod of the workshop, and by generalising it, as the workman did, before it had been followed by modern science. The fact that science brought us always to this end was a remarkable point. But they must prepare food adapted to the weak digestion of those who would have to take it, and not attempt to travel over too large a field of ground at the beginning.

Mr. Christian Mast, as a teacher, begged to express bis concurrence in the views of the reader of the paper, but he should like to have heard something more upon one important point as to when to begin the study of chemistry in private schools and Board schools, or whether it sbould be restricted to secondary schools. It was impossible to teach cbemistry soundly unless practically. You cannot teach chemistry without making experiments. You cannot talk about oxygen without showing how it was produced. The distinction between scientific and practical teaching falls to the ground. They cannot but go hand in hand. To teach chemistry by books was utterly absurd, for the basis of such teaching must be experimental. But to leave out science from the teaching would again be very wrong. Consequently, as a teacher, he was very pleased that Mr. Thomson laid great stress on the fact that the teaching must be scientific, but resting on experiments. As to the time it ought to commence, an interest in chemistry ought to be obtained soon; for, after a youth had attained a certain age, he became too idle to enter into the subject thoroughly; and unless his education had been sufficiently good, he would not be able to understand scientific teaching at all. The minds of children ought to be accustomed from an early age to treat all kind of teaching scientifically. It ought to rest on analysis and synthesis, and both ought to go hand-in-hand from the very first. It would be easy to range the schools in gradation, as on the Continent. There are large technical schools on the Continent, but not for everybody, only for those who were prepared for them, but from the lowest school upwards there was a method and a preparation, and they were arranged according to time and qualification, and we ought to have such a system in this country, so that any one can find an opportunity of getting what he requires, from the youngest to the oldest.

Mr. Thorp, speaking from the manufacturers' view of the question, said many thanks were due to Mr. Thompson for having cleared up an ambiguity which he thought perplexed the subject. Many people imagined, when they heard of the technical education of workmen, that this education was to be given to all working men who are employed in our factories. This was scarcely desirable, for that would not tend to improve their work. On the other hand, unless some fundamental changes could be brought about in the working men themselves, it seemed to him scarcely possibly to do it at all, for he was afraid a very large proportion of the working men were incapable of such education. He thought the technical education in the proposed university should be directed to two somewhat distinct yet parallel things—the one to give a certain general knowledge of scientific method to foremen in factories—for he was afraid they could not go much lower tban that or to men of equivalent intelligence, which would enable them to understand a little more readily the scientific principles involved in the work committed to their care. And on the other hand, to enable tho experts, the men who will be managers, or department managers, or in some sense the responsible scientific heads, to get a little more readily some technical knowledge than they can now. He quite agreed with what Mr. Wood had said that pure and applied science are one. There was no real distinction between pure science and technical science. There ought not to be any such distinction: fundamentally there was not. The very object of scientific education was to assist in training the chemical expert in that which he might be deficient. His own experience, when he left laboratory work, was that he was greatly ignorant of the various matters necessary for him to know in passing from the laboratory school to the manufactory. Questions of fuel, of the materials to be employed, and of the nature of the plant to be used, were tbings that ought to be taught in our scientific schools. The chemist in his laboratory was in the habit of freely using forces he hardly knew how to deal with on the large scale in the manufactory. If instead of dealing with 5 or 10 cubic centimetres of anything, be was dealing with 10,000 gallons, he would find the question of the application and the amount of fuel necessary an important consideration, and the length of time over which the working extended was a very serious difficulty with which he had not to contend in the laboratory, and one which might seriously affect the whole process. In the laboratory he might use a very small crucible and a glass stirrer, but when he came to the manufactory and had to deal with 100 tons of material, he could not use a glass rod, and then he felt

very much the difficulty as to what material to use for a stirrer, and as to what form of mechanical power to apply. The mechanical apparatus used in the various applications of chemistry could in the main be taught to our students. So a technical university should give these two things—a general scientific train- to the foreman, and at the same time, a kind of special technical education to the expert. But while that might very much simplify some of the difficulties the experts had to contend with, it would not lessen the difficulty of obtaining them. Chemists have to be born and not made, and although you might help them forward you could not produce them to order. Therefore he thought it would be always necessary that laboratory processes should be fundamentally in the charge of one or two, or at all events, a limited number who have had special training and education in early life, with some high amount of general education—a totally distinct class from that from which the working men are generally drawn.

Mr. Wills thought you might divide scientific workers into three great divisions. First, the investigator; secondly, the teacher; and, lastly, those who apply the labour of the other two. These three might exist quite distinct from each other. Fortunately, in some cases, they were combined in one single individual, but they might exist quite apart. There were first those who, in the laboratory, search out by experiment the various processes in embryo; then those who take the results as they found them in this stage and teach them to others; and then those who, in some form or other, apply them to manufacturing uses. Between the first and the second class there were points of union. There was great connection between those who investigate and those who teach; frequently they were identical individuals. They were brought into personal contact frequently. But there was a great gap between those two and the third, and in this class he did not mean those only who simply initiated the process, but those also who had to attend to the operation themselves. It was remarkable what a little knowledge as to practical operations existed amongst even some of our chief scientific men, and this was due, undoubtedly, to the small amount of teaching which was to be obtained in that direction. He quite agreed with the remarks which had fallen from Mr. Thorp, as to the difficulties of carrying out on the large scale processes which were amongst the easiest and most simple in the laboratory. Take the case of purifying coal gas; it was easy enough to wash traces of ammonia out of a gas on the lecture table, but when many million cubic feet of coal gas had to be washed per day, practical difficulties occurred even in getting rid of such a soluble body as ammonia. In the establishment of a technical university for systematic teaching, there would be some difficulty in combining these two distinct classes, that is men sufficiently scientific to be able to grasp the theories and having the knowledge which was required as a chemist, and yet most thoroughly competent to enter into the practical difficulties occurring in a manufacturing operation. Of the necessity of such teaching there could be no question. He had had reason lately to look a little into the matter of coal mine explosions, and he was quite surprised at the small amount of scientific knowledge possessed by those engaged in the working of coal mines. The so-called safety lamp was very little understood by many of the certificated colliery managers, and it was treated sometimes in a manner which might bring about an explosion, from ignorance of the principles on which it depends. A technical university would compel the workmen to know the principles on which a miner had to depend for his safety from accident.

Professor Tennant, referring to the observations of Mr. Wills as to the utter ignorance of the principles of the safety lamp, said it had been asserted that a thousand lives a year were sacrificed in coal mines, which, by a little care, might be spared. The subject had often been brought forward before this Society and at other places, and the late Mr. Mackworth had asserted in that room 21 years since, that one-third of the lives sacrificed might be saved if the miners were acquainted with the principles of the safety lamp.

The Chairman, in closing the discussion, congratulated the Society, not only upon the paper, but upon the very useful discussion which had ensued thereon. They were all agreed upon the importance of this increased technical education in the matter of chemistry, as well as in other things. Those who were acquainted with the different means of knowledge which workmen possessed on the Continent, could understand the importance of it at once. In a large number of particulars the products of continental manufacturers were superior to our own, and if our own workmen were not driven out of the market, they were certainly in danger of being so in a great number of cases. The practical question was how we were to get this technical education recognised as an essential part of our national system. It was a very happy circumstance that it was being recognised in a great number of quarters, and that the City companies had applied themselves to the matter. They had laid aside the more ambitious project first started, and turned to what seemed the better one, of aiding technical schools in various parts of the country, and gradually leading up to the establishment of a technical university at no distant time. Then suppose they had a technical university, or various technical schools where the workmen and the apprentices might learn those scientific principles so necessary to success, the question was whether we had done everything we ought to do, and whether the workmen ought to go to these technical classes after they leave school. He did not think they were ready for it. He did not think they would make much progress in these technical classes unless their minds had been trained in earlier years to some knowledge of the things with which they had to deal, and of which the world was composed. They had not to consider the higher schools in the country, because they did not furnish the workmen, but the elementary schools, which teach, roughly speaking, all the workmen, or six-sevenths of the general community, and at all these elementary schools chemistry should be taught. Certain sciences were introduced in the 4th, 5th, and 6th Standards as specific subjects, such as mechanics, physiology, and botany, but chemistry was not one of those subjects that might be taught so as to get a Government grant, and it was very difficult to get any subject taught at the Board or voluntary schools by the managers that did not come within the class of subjects recognised in the Education Code. A very desirable amount of knowledge was often communicated to little children in object lessons in the infant classes; but while passing from the infant school to the third Standard there was hardly any science imparted to them in any sort of way. What was wanted was, not that we should teach chemistry exclusively, but that we should at any rate give such a knowledge of the elementary constituents of matter as would fit the young workman to be taught the higher branches. They ought to be trained in the habit of using their eyes and ears, and their other senses, in early years, and they ought to be led up through the different stages of the school till they reached the more advanced teaching, which would fit them for the special instruction which they might afterwards receive in the technical school or university.

Mr. Thomson, in reply, remarked that he quite agreed with the speakers who had insisted on chemistry forming a part of elementary and secondary school education, and thought that he had expressed himself in favour of that view. He also meant that the chemical instruction, of whatever kind, designed for artisans, should, while of

a scientific character, like all elementary teaching, be quite simple and fully experimental.

The Chairman concluded by moving a vote of thanks to Mr. Thomson, which was passed unanimously.

TWENTY-THIRD ORDINARY MEETING.

Wednesday, May 29th, 1878; The Rev. Sir GEORGE W. COX, Bart., in the chair.

The following candidates were proposed for election as members of the Society:—

Bouch, John, J.P., Montpelier-house, New Brighton, Cheshire.
Clayton, R. C. Browne, J.P., Athenæum Club, S.W., and Glenfinnay, Torquay.
Ffoulkes, William Wynne, Old Northgate-house, Chester.
Fox, St. George Lane, St. Stephen's-chambers, Telegraph street, E.C.
Metcalf, Richard, Paddington-green, W., and New Barnet, Herts.
Trevenen, Noel P., Hampton Court Palace.

The following candidates were balloted for and duly elected members of the Society:—

Barrow, Benjamin, J.P., F.R.C.S. (Mayor of Ryde), Southlands, Ryde, Isle of Wight.
Bartleet, Major-General Henley Thomas, 2, Louisa-terrace, Exmouth, Devon.
Gover, Henry Charles, 86, South-hill-park, Hampstead N.W.
Hargreaves, William, Moss-bank, Halliwell, Bolton.
Sakurai, G., 86, Albert-street, Regent's-park, N.W.
Sutherland, Gilbert D., M.A., Ph.D., Commercial Schools, Warrington.

The paper read was—

MYCENÆ, TROY, AND EPHESUS.

By William Simpson, F.R.G.S.

Mycenæ was, according to the story, the capital of King Agamemnon, who commanded the Greeks in the expedition to Troy. It is almost hid in a corner of the plain of Argos, where it is situated in a ravine between two prominent hills. Portions of the old walls forming the Acropolis are still standing. Some parts of them are yet good, and in such condition that they might be useful for defence in the present day. Without the walls are the remains of some tombs, and a fragment of an old Cyclopean bridge; and that may be said to be all that has been left of the ancient capital of Argos. It is not much, but when time is considered, we may marvel that even this much has been left to us. According to the usually accepted history, Mycenæ was destroyed in the year B.C. 468, and the place was supposed to have been deserted at that time, and to have remained so ever since. The absence of population may perhaps explain why it has withstood the ravages of so many years; to this may be added the lucky circumstance that there was also no town close at hand to use the old walls as a convenient quarry. The place seems at a very early date to have dropped out of history, and to have been lost, or, at least, forgotten; to these causes, perhaps, we owe the existence of some most interesting specimens of early building, and the safe preservation of the oldest specimen of sculpture in Greece, that is, the lions over the gate of the Acropolis. This obscurity in which Mycenæ was shrouded, can be evidenced by what Strabo says, for he states that it had been razed by the Argives, and that in his time not a trace of the city was to be seen. (lib. vii., c. iv., 10.) The out-of-the-way corner in which this old city stands, may explain why so little was known of it, and will account for Strabo not finding the spot, or it may lead us to understand why those whose information he had trusted chanced to be unconscious that the old Cyclopean walls were still visible.

A century and a half later, Pausanias seems to have had more success in seeking for the capital of Agamemnon, and his description of it is so exact that we may assume he visited the spot and saw it with his own eyes. As this author writes with all the minuteness of an inventory, it may be as well to give his words. He says—

"Among other parts, however, of the enclosure which still remains, a gate is perceived with lions standing on it, and they report that these were the work of the Cyclopes, who also made for Prœtus the wall in Tiryns. But among the ruins of Mycenæ there is a fountain, called Persea, and subterraneous habitations of Atreus and his sons, in which they deposited their treasures. There is also a sepulchre of Atreus, and of all those who, returning from Troy with Agamemnon, were slain at a banquet by Ægistheus. For there is a dispute between the Lacedæmonians, who inhabit Amyclæ, and the Mycenæans, concerning the sepulchre of Cassandra. There is also a tomb here of Agamemnon, and of his charioteer, Eurymedon, and one sepulchre in common of Teledamus and Pelops, who, as they report, were twins, and the offspring of Cassandra, and who, while they were infants, were slain by Ægistheus at the tomb of their parents. There is likewise a sepulchre of Electra, for she was given by Orestes in marriage to Pylades, from whom, according to Hellanicus, she bore two sons, Medon and Strophius. But Clytemnestra and Ægistheus are buried at a little distance from the walls; for they were not thought worthy of burial within the walls, where Agamemnon and those that fell with him were interred." (lib. ii., c. xvi.)

Although these words were written over seventeen centuries ago, in the main they give a fair account of the place as it exists at this moment.

The principal part of the walls are of the most primitive style of Cyclopean masonry; that is, of large, and seemingly unhewn stones, without mortar or cement of any kind. Where such rough stones leave wide spaces between, these openings are filled up with smaller stones. At the Gate of the Lions the stones have been wrought, and may be described as rectangular, and yet they are different from the later rectangular, which belongs to the Hellenic period. The gate itself is formed of two massive upright blocks, which form the posts or jambs; these are 10 ft. 8 in. long, this giving at the same time the height of entrance, which is 10 ft. 3 in. wide on the ground, they slope inwards, reducing the width of the opening by 9 in. at the top. The large block forming the lintel is 15 ft. by 8 ft. Whatever may be the date of this work, we have evidence of considerable experience and care in the mode of construction as manifested in this doorway. Strong and massive as the lintel is which bridges this gate, a triangular space is left vacant above, so as to relieve it of any superincumbent weight. There is a somewhat similar plan carried out in the Great Pyramid, and it may be said to be the finest specimen of building in the world. In this triangular space over the gate at Mycenæ still stands the sculptured slab with the lions, which has given the gate its well-known

name. It is supposed to be the oldest known sculpture in Greece. This would give it an interest in itself, but it has other claims which attract our consideration. In the first place, it may be asked, what is the meaning of this ancient piece of sculpture? There is a short pillar which rests on a pedestal, on each side is an animal, supposed to be a lion, they stand in positions not unlike that of heraldic supporters as used in coats of arms in the present day. The upper portion of the slab is mutilated, the animals' heads do not exist, and we are also left in doubt as to how the pillar terminated. The capital of this column has been described as being Doric; this is not quite correct. It can only be said to resemble that style more than the others, but it is not Doric, nor can it be identified with any style of architecture known as belonging to Greece. I am inclined to agree with the idea which has been expressed by more than one authority, that the heads of the lions were not cut on the stone, but were formed of metal, and fixed with nails or bolts; there are holes which may have received these nails still existing, which give a strong colour of probability to this theory. This renders it highly probable that there may also have been some symbol in metal which surmounted the pillar, and the loss of which may leave us in the dark as to the significance of this most interesting specimen of ancient art.

Many suggestions have been made by way of explanation of these two lions and the pillar, but as yet no definite conclusion has been arrived at. One theory is that the pillar was a symbol which had reference to the Persian solar worship —another conjecture made the pillar sacred to Apollo under the title of Agyieus, in which character Apollo was the guardian of streets and public places, and that he would thus be the appropriate deity of gates and vestibules. I will give a quotation from the Iphigenia in Tauris, which we may suppose is an authority on matters of this kind. It is Iphigenia, the daughter of Agamemnon who speaks. She says:—

> "Methought, that having changed this barb'rous land
> For my dear native Argos, there once more
> I dwelt and slept amid my virgin train;
> When, lo! a sudden earthquake shook the ground;
> I from the tott'ring chamber frighted fled,
> And where I stood aloof, methought, beheld
> The battlements disjointed, and the roof
> From its aërial height come tumbling down.
> One only pillar, as it seem'd, remained
> Of all my Father's house; whose capital
> Was with dishevel'd golden tresses hung,
> And, stranger yet, with human speech endow'd.
> This pillar, reverently acting then,
> The duties of the function here enjoin'd me,
> I purify'd with water, as ordain'd
> For sacrifice, and as I wash'd, I wept."—v. 44.

This only pillar she identifies with her brother Orestes, and a few lines further on she adds:— "For sons are pillars of a family." As representing the son, the pillar is thus a symbol of the continuation of the family, and of the stability of the house. To this Iphigenia adds another function, which is quite in keeping with the involved nature of ancient symbolism. She, believing that her brother was dead, purified the pillar with water, as ordained for sacrifice, thus making it a funeral stele, or altar. The lions, in this view of the subject, would thus become the guardians of this sacred column, and at the same time they would be the guardians of the gate, and of the house of Pelops. It would be curious if the lions at church doors, which were common about the twelfth century in Italy, could be traced back to this ancient example at Mycenæ. The gate, as a seat of justice, is most ancient, and the church door became a place, in the Middle Ages, where decrees were published, the lions were such a recognised feature of the door, that many of the proclamations and documents began with the formula of "*Inter Leones.*" (De Caumont, p. 168.)

Another important consideration is the origin of the style of sculpture on this slab. Up to the present, scarce even a guess can be made as to the date which ought to be assigned to it. The art upon it is good, so good that it implies progress and a considerable period of time to reach the condition of culture necessary to produce such work. It stands alone, and unconnected with any other specimens of art in Greece. We have no other works which could be pointed to as the steps leading to the state of development indicated in the high finish of these lions. They seem to belong to a different school from that of the later Greek art. The problem has been as to where the influence which produced this style came from. The usual explanation has been that of an Asiatic contact. This theory, of course, involves the still broader theory that the first influence which gave birth to Hellenic art came from Asia. The strong resemblance in the style of art on these lions at Mycenæ and the sculptures from Nineveh, has naturally led to the supposition that the style came originally from the valley of the Euphrates. Or it may have been in some allied school which flourished in Phœnicia, for we know from Homer that Sidonian art was at an early period much valued by the Greeks. From the most remote period there was a constant communication between Greece and the north-west corner of Asia Minor, and this link would also explain how art knowledge, or even the artists themselves, might be transported from the one region to the other. The story of Pelops coming from Lydia, and being able to give his name to the whole Peloponnesus, may be partly, or even wholly, mythical, and yet the probability is that some migration of power, or of race, took place, and with it would, no doubt, be carried whatever superiority in art the invading race may have chanced to possess. The Greek authorities seem also to favour this idea. Pausanias states— and we may suppose that he gives the explanation which was current at his time—that the gate and the lions upon it were the work of the Cyclops, "who also made for Prœtus the wall in Tiryns." Now, Prœtus, according to the story, had been for some time an exile from the Peleponnesus, at the Court of Iobates, the king of Lycia, and from Strabo we learn that the Cyclopes came from Lycia. Thus far, there seems to be an agreement in the tradition as to the direction from which these workmen came. When we ask as to who or what these Cyclopes were, nothing like a satisfactory answer can be derived from the allusions to them which we find in the Greek authors. According to Strabo, there were seven of them, and they were called Gasterocheires, or "hands and stomachs," because they subsisted by means of their art. These Cyclopes from Asia, seem a very different race from those described as belonging to Sicily, who had only one eye in the middle of their

foreheads. The only point of resemblance between them was that both were connected with labour and with art. Those of Sicily were supposed to be the assistants of Vulcan, and were, of course, metal workers, whilst the Cyclopes of Asia were stone-builders. As the stone age dates before that of bronze, we may assume it as probable that the Asiatic Cyclopes belonged to a more primitive period. The questions connected with these ancient art-workmen, are very important, and are very tempting to go further into in a paper for a society such as the Society of Arts, but I must limit my remarks, and proceed with the subject.

It was just within the Gate of the Lions, and close to the outer wall of the Acropolis where Dr. Schliemann made his excavations. Here he came upon the five tombs—a sixth has since been discovered by M. Stamataki — which yielded such a harvest of golden treasures. Here were found the golden goblets, masks of the same metal, and the celebrated buttons, or bosses, covered with thin sheet gold, and other interesting objects, too numerous for me to recount in this paper. Instantly on discovering these tombs, Dr. Schliemann declared to the world that he had found the graves of Agamemnon, and of those killed with him, by Ægistheus on their return from Troy. The value of this declaration may be estimated when it is known that our best archæological authorities on such matters, both here and on the Continent, cannot agree as to the probable date of the objects which have been found; and I may add, that there is a very wide interval of time implied in this uncertainty by the various theories which have been suggested. The few sculptured stones which were brought to light most certainly do not belong to the same style of art as that on the Gate of the Lions. The work on the lions is good, and the men who produced them are fully entitled to be called artists; but it would be an abuse of that term to apply it to those who executed the ornaments and figures on the stones lately found in the excavations at Mycenæ. Whether they belong to a primitive period, and were the early efforts of art, or that they indicate a deterioration in taste, and ought to have a late date assigned to them, is one of the questions at issue; and unfortunately, the materials necessary to guide us in giving a judgment on such a point are as yet rather scanty.

One very remarkable monument was uncovered in these excavations, and it might be said that every feature connected with it was new to the student of Greek archæology. On this account it was rather a puzzle to explain its purpose. When fully laid bare, it presented much the appearance of being what we understand by a Druidic circle. A close inspection showed that the slabs had been wrought, and that they were carefully fitted to each other; round a portion of the circle a second circle of slabs was still standing; this second circle was concentric with the first, and only about three feet apart; at one place there remained a few slabs, which formed a covering between the two circles. These horizontal slabs were mortised into the perpendiculars. That these covering slabs were originally all round the circle was evidenced by the existence of the mortices on many of the upright slabs. These were distinctly visible, and the conclusion which had to be formed from this was, that when the structure was complete, it must have formed a circular ledge or seat. It was nearly 100 feet in diameter, and the whole suggested the idea of an arena, or place for some public performance. At the point of the circle nearest to the Gate of the Lions the entrance to this enclosure still remains.

It was while sketching on the spot that I was able thus to realise what the place had been at first, and recalling the description of the Shield of Achilles, where there is a crowded assembly, and the trial of a case is going, the poet says, that "the elders sat upon polished stones, in a sacred circle" (Iliad, lib. xviii., v. 503). The word rendered polished might also be given as "smoothed," or "worked," as applied to the stones; and thus we have a Homeric description which agrees perfectly with this discovery at Mycenæ. On sending home my sketches to the *Illustrated London News* of the spot, I suggested this explanation of it, and in addition to the account in the Shield of Achilles, I added a reference to the Agora of the Phæacians (Odyssey, vi., v. 265), which is also described as being round in form. Additional references have been made by others as to the circular character of ancient Greek Agoras, and this theory is now that which is generally accepted in regard to this monument.

It would be a very important point if it could be determined whether the Agora was appointed at this spot after the tombs, or if the important personages had been buried there as a mark of honour. Instances of Agoras, with tombs and monumental shrines within them, did exist. Pausanias mentions, that among the Megarenses there is a senate in the place which was said to be the sepulchre of Timalcus (lib. i. 42). He also states that these same people built their place of consultation "in such a manner that the sepulchre of heroes might be contained within its ambit" (lib. ix. 43). In the city of Elæa he also mentions a stone sepulchre, and states that it "is in that part of the forum which is in the open air" (lib. ix. 5). Themistocles died at Magnesia, where he was buried, and according to Plutarch a very handsome monument was erected to him, "which still remains in the market place." Herodotus states that "there was, and still is, a shrine dedicated to Adrastus, son of Talaus, in the very forum of the Sicyonians" (v. 67). In the Agora of Corinth, according to Zenophon, there was the sepulchre of Euphron. Some of these instances seem to imply that the place of public assembly was arranged so that the ashes of the heroes who were buried there would give a sanctity to the place. The circle of stones upon which the elders sat, as described on the Shield of Achilles, is called a "Sacred Circle," which confirms this idea. Where persons of distinction have been interred in an Agora, or had a sepulchral monument raised to them, it has evidently been done as a mark of high honour. Hence, in whatever way we may interpret the graves discovered in the Agora of Mycenæ, we need not hesitate to accept the theory that they were individuals of high repute, and that they must have been held in considerable honour by the inhabitants of the place. The amount of golden objects found with the bodies, the value of which has been estimated as equal to 5,000

British sovereigns, becomes another evidence in confirmation of this.

There is another class of monument at Mycenæ which I consider to be of great importance, as bearing not only on the archæology of that place, but also in relation to the whole question of the origin of Greek art or architecture. These are the so-called Treasuries, of which there are two almost perfect specimens at Mycenæ, and a number of smaller and ruder examples as well. There are others in various parts of Greece, one of the best known amongst these being the Treasury of Minyas, at Orchomenus. Still, none of these are in such good preservation as that of the so-called Treasury of Atreus. It is a splendid dome of wrought rectangular stones, about 50 feet in diameter, and about the same in height. The stones are laid in courses horizontally, and not arranged on the principle of the arch, this being the primitive mode of construction for domes nearly all over the East. The stones of this dome are not large, but the entrance is formed with two very large blocks, which do duty as lintels. One of these, the inner one, is 27 feet long, 17 feet wide, and 3 feet 9 inches thick. The second block is not so large as this, but still is an enormous mass of stone. Strong as these blocks are, the builders here again give us an illustration of the care with which they did their work, for over these huge lintels they have left a triangular opening similar to that at the Gate of the Lions, so as to relieve them from the weight of what was above, thus identifying the two structures as belonging to the same school of architecture. On the outside there is a long approach to this door; it is 20 feet wide, and constructed of squared stones; and it ought to be stated that there is an inner rock-cut chamber, which is entered on the north side from the dome.

In speaking of this monument I have used the term "so-called Treasury," and I have done this because I dissent entirely as to the character which is thus implied by the name. I had been familiar with the structure before my visit to Mycenæ from the usual representations of it in architectural works, but I had never thought seriously as to its purpose. An inspection of a building on the spot leads to a more intimate knowledge, and the mind at the same time generally demands an answer to such questions as the why and the wherefore. A very few minutes' inspection was enough to satisfy me that this monument was an ancient tomb, and I see no reason yet to alter that judgment. The influence which led me to this conclusion was that I felt myself forced to accept the fact that it belonged to that class of ancient monuments which are described as "chambered tumuli." It so happens that I have seen and made drawings of a good many of these monuments in various parts of the world, from our own pre-historic burial mounds even as far as the old tombs of the Ming dynasty near the great wall of China. Within this very wide geographical space there are some considerable differences in the ancient places of sepulture, still there are some marked features which are common to a large class of them, and these features are to be found in the Mycenæ examples. The so-called Treasury of Atreus being formed into the side of a hill, its character of being a tumulus is not at first apparent, still we can yet see that the earth has been heaped up over the top of the dome, just sufficient to tell us that it is a heaped up mound. All doubt is removed by the character of the third and fourth so-called treasuries, which are not dug out of a hill side, and when they were constructed must have stood up as distinct mounds. That these structures were not treasuries, in the usual meaning of that word, can be made very evident. Had Atreus, or any other king of "rich Mycenæ," ever made for themselves buildings in which to deposit their wealth, they would have made such places within the walls of the Acropolis. Security would have been the first consideration, and that such was not the purpose of those who constructed these so-called treasuries is evident from the fact that they are not within the old Cyclopean wall of the stronghold. This entirely precludes the notion that their object was the keeping of valuables. As they cannot have been treasuries, we have necessarily to fall back on their character of being tombs. Here only can we find safe footing, for we can explain that it was owing to their being tombs that they derived the reputation of being treasuries. All over the East every large and important tomb was looked upon in the past, and is so considered down even to the present moment, as being the depository of wealth. The pyramids of Egypt have always been supposed to contain immense treasures. The great mounds of the Bin Tepé, near Sardis, are also supposed by the people in the region to contain unheard of wealth, which will yet be found when these old burial heaps are opened. Thus it is easy to explain why these ancient places of sepulture have attached to them the name of "Treasuries."

I think it is important to realise the true character of these remains, for Dr. Schliemann has, in his work lately published, entirely ignored their claim to be considered tombs. Accepting them in this light, I think that the next conclusion must be that these are the tombs mentioned by Pausanias in the quotation which has already been given. It will now be understood why Dr. Schliemann refuses to admit the sepulchral character of these monuments, for he claims that the tombs discovered by him in the Acropolis are those mentioned by that author. The probabilities against his theory are supplied by himself. In his work on Mycenæ, at p. 102, he asserts in a very positive manner that he has found the sepulchres as described by Pausanias, yet he is forced to confess that the tombs which he has lately excavated, as well as what he calls the tombstones above, could not have been seen by Pausanias, for "when he (Pausanias) visited Mycenæ, about 170 A.D., all the sepulchral monuments had for ages been covered by a layer of pre-historic *débris*, from 8 ft. to 10 ft. thick, on which an Hellenic city had been built, and had again been abandoned about four centuries before his time, after having added a layer of Hellenic ruins, 3 ft. thick, to the deep strata of pre-historic remains. Thus, he could only have known of the existence of these sepulchres by tradition." The statement in this last sentence being given without any reason to support it, it must go for what it is worth. The probability of a tradition lasting for so many centuries, and coming down from a pre-historic age after all outward trace of the graves have disappeared beneath so many layers of rubbish, does not commend itself to our minds. Neither does it commend itself as

agreeing with the words of Pausanias, who makes no allusion to any tradition, but speaks of the tombs as existing, and refers to them in the same terms as he does to the wall and the Gate of the Lions; hence, we may suppose that he saw them on his visit.

There is one very important point which I wish I could do justice to in this paper, but I can only allude to it; and that is, that these so-called treasuries, and the Gate of the Lions, belong to a style of architecture entirely different from that which we have been accustomed to call Greek. The term Pelasgic has been applied to all early Hellenic remains, but the word, like many others, is a doubtful one, particularly as we do not as yet know from what source the influence came, nor are we quite certain of the race who first produced it. This much we may safely say, that it is older than the style which we associate with the idea of classic Greek. We can also say that this style had an entirely different origin from that of the later Greek. The Greek temple is an imitation, in stone or marble, of a pre-existing wooden type. The Mycenæ remains have not the slightest indication of a wooden origin. The style began from the first with stone, and with the placing of one stone on the top of another; most probably the rude Cyclopean walls were the first efforts at it. The third and fourth treasuries are very primitive attempts; in fact, they are more like the Dolmens of our own Druidic monuments than anything else. In them we can see the rude beginnings of the style which led, ultimately, to such a splendid monument as the so-called Treasury of Atreus. Its substantial masonry has endured through a long course of ages, showing the careful work of its builders. It was all covered within with bronze; the holes of the bronze nails are still visible. In the British Museum there are one or two fragments of marble, with ornament upon them, which are supposed to have been part of the ornamental encrustation which was originally over the whole of the doorway, and of which Professor Donaldson made a restoration over 30 years ago.

I have identified the style of architecture of these monuments with that at the Gate of the Lions. The supposition that the builders of these last came from Asia Minor has to depend upon what is little better than traditional evidence, but this evidence finds support in the following quotation from Athenæus, which bears on the original constructors of these tumuli. He says, "You can see everywhere in the Peloponnesus, but especially in Lacedæmon, very large mounds, which they call the tombs of the Phrygians, who came with Pelops" (xiv. 12). Athenæus is a late author; still, whatever value this statement may have, it goes so far to prove that those who introduced these mounds into Greece were the same as the Cyclopes, whoever they may have been, and it is also evidence that these mounds were not treasuries, but were tombs, as I have endeavoured to explain them. It may be added that Æschylus describes the tomb of Agamemnon as "the mound of his sepulchre."—"Choephori," v. 4. Sophocles does the same; he makes *Electra* say, "For when I came to my father's ancient tomb, I see from the top of the mound," &c.—"Electra," 894.

I must ask you now to leave the Peloponnesus and go to the Troad with me, where, I regret to say, you will find everything in a much more theoretic and uncertain condition than is the case with the remains at Mycenæ. The site of Troy has been a subject of dispute even from the earliest times, and I cannot say that we are now any nearer to a settlement of any of the questions connected with it. Strabo gives a long account of the Troad, and deals with the authors who had written before his time regarding the site of Ilium. There was a place which bore this name in his day, but he states it as his opinion that it was not on the same ground as the city of Priam. He says, "That the port of the Achæans," that is, he means, the ground on the Hellespont where the Greeks had their ships and their camp, was "distant from the present Ilium about 12 stadia, and 30 stadia more from the ancient Ilium, which is higher up in the part towards Ida." (B. xiii. c. i. 32.) I would say that Hissarlik was the probable Ilium of Strabo's time, and that he supposed the more ancient city to have been near, or at least in the direction of Bounarbashi. Le Chevalier visited the Troad in 1786, and ever since his time there has been a more modern contest regarding the site of Troy. Le Chevalier urged the Bounarbashi claims. Since his time MacLaren and Eckenbrecher have declared for the position at Hissarlik; and lastly, Dr. Schliemann applied the test of the spade to this ground, and as a result, he proclaimed to the world that he had there discovered the Ilium of Homer. This would be a most important discovery, not merely from its archæological aspects, but from its bearing on so many questions connected with classic literature. On this account we should be quite sure that the grounds for such a conclusion have had due consideration. We ought to be certain that such an announcement is not a hasty judgment, arrived at because desired; on the contrary, before accepting the statement we should be certain that every point had been weighed with calmness, and by a mind experienced in such matters, and that no part of the case had been assumed without the utmost care and reflexion. Hissarlik is a mound at the end of a long ridge which projects into the Trojan plain. Before the excavations, a person might have passed the place without perceiving any signs of a town having ever existed on it. Its name, which is Turkish, means "Place of a Fort," and is pretty good evidence that up to a late period it must have retained some visible marks of its original character. This mound is higher than the rest of the ridge to which it belongs, but much of it is accumulated soil. A closer inspection of the ground to the east and the south soon reveals lines on the ground which must have either been walls or streets. Dr. Schliemann gives a plan of this ground, which represents the walls as enclosing a space of over two miles in circumference, and Hissarlik, which is only about a furlong in its longest direction, seems to stand out as the fortress or citadel of this town, which from its size must have been an important place at some former period. It was on this old citadel that Dr. Schliemann made his grand attack with the spade, and for three years he persisted in carrying on this modern siege of Troy. Although I cannot agree to the conclusions which the Doctor has come to, yet I can speak of the energy which must have been expended, and of the wonderful extent of the work

accomplished. One of the trenches extends east and west over a space of about 600 ft., another from north to south is about 500 ft. long. In some places these valleys, for so I might term them, are 50 ft. deep. It would be rather difficult to describe to you minutely all that was laid bare by these extensive diggings. I think that an inspection of the drawings which are here exhibited will give you a better idea then could be conveyed in words. You will see that the sections made by the cuttings reveal old walls and masses of stones which seem as if they had been thrown in with the soil. You will also notice that the best masonry is close to the present surface of the ground. Lower down, there are houses whose walls are of the rudest construction. There is a long paved ascent, and down almost at the lowest point there are the remains of an old gateway, which Dr. Schliemann has declared to be the "Scæan Gate."

It may, perhaps, be best for me to give you the ideas which resulted in my own mind, and to relate them to you, by detailing my thoughts as they grew out of the visit and the study of the details. Well, the first impression of doubt was produced from the total absence of any Cyclopean masonry, as revealed by the excavations. Dr. Schliemann himself says that, "The great tower of Ilium, the Scæan gate, and the great enclosing wall, are generally composed of unhewn stones joined with earth." ("Troy and its Remains," p. 26.) These are his own words, and such building does not belong to what we call Cyclopean. In fact, the Doctor, at the time he was carrying on the works at that place, emphatically denied the possible existence of such walls. One of his critics, Mr. Calvert, a gentleman who has long studied the archæology of the Troad, had expressed his opinion that Cyclopean masonry did exist in the depths of Hissarlik; and it is a curious peep into the condition of Dr. Schliemann's mind at that time, to find him saying, in reply to Mr. Calvert, that "the architect is not yet born who could construct house-walls of such stones without some kind of cement" ("Troy and its Remains," p. 273). That is a very remarkable statement for an archæologist to make. I confess that I am inclined to agree with Mr. Calvert, that Cyclopean masonry will yet be found; but at present we have only to deal with what has been discovered. The Doctor may not be quite correct in stating that the architect is yet unborn who could build a Cyclopean wall, but he is accurate enough in his description of the walls, so far as they have yet been brought to view. Before deciding that these walls at Hissarlik belonged to the Homeric Ilium, we ought to have some evidence as to their probable date; unfortunately, this is a matter which the Doctor does not trouble himself with. A wall constructed of unhewn stones joined with earth, presents us with almost no clue as to the time of its erection. It might have been made at any date. Such a wall might be of the Heroic Age, or it might belong to any period down to the present moment. It is entirely destitute of any architectural art; it has no mouldings, no ornament, and no inscriptions. Such being the case, no data can be derived from it as to the period of its construction. My own conclusion was, that the walls of the City of Priam were most probably of Cyclopean masonry Troy was contemporaneous with Mycenæ and Tiryns, and it would be reasonable to expect some resemblance in the architecture of these places. Homer applies similar terms to both Mycenæ and Troy, such as "well-built" and "wide-wayed." These may have been but stereotyped words in the mouths of the Rhapsodists, but I have already pointed out, as the probable deduction from the myths regarding the Cyclopes, that the style of building known under their name, came from the western shores of Asia Minor. If such were the case, we may be sure that that description of building was practised in the region they migrated from, and the walls of cities belonging to their date—whenever that may have been—were much more substantial than what we have as yet seen at Hissarlik. I am supported in this conclusion by the fact that there are remains of Cyclopean masonry in the Troad. There are sketches of the walls of Gergis before you to-night, where such construction can be seen. I am also informed that there are old Cyclopean walls yet existing at Alexandria Troas, which is only a few miles distant from the Troad. Dr. Clarke describes Cyclopean buildings on the sides of Mount Ida, which, he says, "are as rude as those of the walls of Tirynthus in Argolis" ("Clarke's Travels," vol. iii., p. 166). On the top of Samothrace, which is so close to Troy that Poseidon from it watched the City of Priam, admiring the war and the battle, there still exists walls of the most primitive Cyclopean structure. I do not see how we can avoid the conclusion that so great a monarch as the king of Troy is described must have had the walls of his capital built in the strongest manner which was possible at the time. We should also remember that, according to Homer, it was Poseidon who built the walls of Troy, and we are told that he did so "that the city might be impregnable," ("Iliad" xxi., v. 447) thus implying defensive works of the most formidable kind. This myth in itself would suggest that the walls were something unusual; such paltry masonry as we see now in the trenches at Hissarlik never could have been the foundation for such a tale. It may be added that Mr. Gladstone has deduced from this story of Poseidon that the walls of Troy were of a Cyclopean character—"Homeric Sychronism," p. 42. The deduction from all these considerations seems to me to be clear and simple. Hissarlik may be the site of the Homeric Ilium, but the remains of it either do not now exist, which is most probable, or as yet they have not been laid open to our view.

Dr. Schliemann has also declared that he has found the Palace of Priam in the depths of these excavations. The only knowledge we have of Priam's residence is from the words of Homer; he describes it as being very beautiful, with "well polished porticoes," and having "fifty chambers of polished marble" for the accommodation of Priam's sons and their wives, also "twelve roofed chambers of his daughter's, of polished marble," where they and their husbands lived ("Iliad" vi., 245). There was also a "vestibule," and "a much-echoing porch" ("Iliad" xxiv., 322). Having been reading up the "Iliad" before visiting the Troad, and having this description fresh in my memory, you may guess my astonishment when a few mud walls were shown to me as this palace. These walls enclosed three small rooms, the largest of which is not over 20 feet in its longest dimensions, and I may add that there is no appearance

of polished porticos; on the contrary, they seem never to have had either doors or windows, so that King Priam and his large family must have gone out and in by means of the chimney. When the guide who was with us told me this was the Palace of Priam, I said if he had announced it as the palace of Priam's pig I might have accepted the statement. There is a drawing here to-night, the accuracy of which I guarantee. You may judge for yourself regarding the style of architecture, and come to your own conclusion as to whether it belongs to the palatial or pig-stye order.

I have still something to say in relation to this palace and its position with regard to the so-called Scæan-gate. This gate is undoubtedly deserving of that name. There are only about three feet of the walls left standing, but the lower part of the door posts are recognisable, and the old stone flags of the roadway are still left *in situ*. From its depth below the present surface, I should say, it is in all likelihood a very old gateway. As the largest amongst the stones in the wall is only two feet long, and the most of them are not half that size, also their being joined with earth, takes them out of the category of the Cyclopean style, I must refuse, on the grounds already given, to suppose that it belonged to the walls of Priam's City. In addition to this objection, I have to point out that the so-called palace is placed right across the roadway of the gate. Its position is only a few feet from the gate, and there the very mud wall yet stands like a barricade, stopping all thoroughfare going either in or out. Imagine a house built across Fleet-street, only a few feet within Temple Bar, and you will have the same conditions. It is clear that if such were the case the traffic out or into the City could not pass by that route. I need scarcely point out to you that no one would be allowed to build a house across a public street, and that close to one of the city gates. The conclusion must be that the gate had been closed up, or rather that it had been destroyed, and had ceased to be used when the houses were constructed, and as it is thus evident that the two did not exist together, they cannot possibly have been the Scæan-gate and the Palace of Priam, as described in the "Iliad" of Homer.

I may add my own explanation as to the gate. It seems to have been destroyed, and at some later date a street was formed over it, cutting down the walls of the gate to about three feet from their base. This new roadway was formed at a right angle to the older line of the gate, and the so-called palace was erected along the line of the newer thoroughfare. This later roadway ascends towards the east, and it is described in Dr. Schliemann's book as "The Great Tower of Ilium."

The palace may have been a habitation constructed by Scythians or Gauls, who, we know from Herodotus, made inroads at times, and even occupied Asia Minor; but whoever it may have been that erected these houses, it is evident that they were not accustomed to such conveniences as doors and windows. Xenophon describes some houses on the route of the Ten Thousand, not much different from these dwellings at Hissarlik; they "were underground; the mouth resembling that of a well, but spacious below; there was an entrance dug for the cattle, but the inhabitants descended by ladders." ("Anabasis" lib. iv. c. 25.) The houses in Armenia do not differ much from this description in the present day.

Although, I consider, these late explorations at Hissarlik as most unsatisfactory in regard to the identification of the Homeric Ilium, yet I would say, if such a place as Troy ever existed, I should give the preference to Hissarlik over that of Bounarbashi. The real truth is that neither of the localities can be reconciled with the Ilium, but Hissarlik, I think, presents the fewest difficulties.

At Gergis, which is the supposed Pergamos of the Bounarbashi site, we do find Cyclopean masonry. At the south-west corner of the old walls there is a fragment of the rude kind, with the large interstices filled up with smaller stones, similar to the walls of Tiryns and Mycenæ. There is alsolater Cyclopean work, as well as walls of rectangular masonry. Drawings of these are in the room.

Much more might be said in relation to Mycenæ and Troy, but I have confined myself as nearly as possible to the buildings or architectural remains which exist, or have been brought to light by the recent exploration. Even within these limits I know that there is more which could be said, but I have done as much as my time would permit. What I have described is what I have myself seen, and not only seen, but have also sketched, which I find fixes details more firmly in the memory than merely looking at objects can possibly do. I have given you the deductions which have resulted in my own mind in regard to these explorations, and it is for my hearers to form their own opinions upon the various points which have been laid before them.

At Ephesus, to which we must now turn, there is not the same uncertainty about the result of the discoveries made by Mr. Wood. The site of the temple of the Great Diana of the Ephesians has been discovered. This important fact has been accepted by all the authorities, and there is not one who can be named as having a doubt on the subject. This being the case, there is not so much to say in relation to it. There are other conditions which also tend to curtail description or criticism; these are, that all the important blocks of marble are in the British Museum, and all that is to be seen at Ephesus is the deep fosse where they were found, and which is now filled with water, and inhabited by a large colony of loud croaking frogs, who treated me to a morning concert when I was sketching there. As you all know, about 20 ft. of soil had accumulated over the original level on which the temple stood; but before this earth had gathered over the spot, the most of the marble had been removed. Still enough was left to reward the discoverer, and to settle some important points. Amongst these, the plan of the temple has now been determined in every detail. The description which existed of this celebrated temple mentioned the existence of sculpture, on the columns, and this was a point which had given rise to much variety of opinion. In this, again, all doubt has been set at rest, for some of the sculptured drums have been found, and one of them may now be seen in the British Museum.

Previous to Mr. Wood's successful explorations there were two theories as to the probable site of the temple, and these also involved the question

as to the position of the Magnesian and the Coressian gates. The site of the temple being now determined, the position of the two gates has also been satisfactorily settled. The question as to which is Mount Prion and which is Mount Coressus, is one I cannot pretend to give an opinion upon; but I should be inclined to think, from the position which the temple occupied, that the early or first foundation of Ephesus was most probably on what is now known as the Castle-hill at Ayasouluk, and that the principal ruins which exist at the present day only mark the site of the later city, which dates from the time of Lysimachus. It is on this Castle-hill that it is now thought the remains of the Cathedral of St. John have been at last found. The remains are undoubtedly those of a Christian church. A few massive blocks of fallen wall is all that is left; the only part of the plan of the church which is now visible, is that of the circular apse at the east end. One of the drawings in the room to-night is called the "Gate of Persecution;" it must have been the entrance leading to the church, and on its arched roof can yet be seen remains of paintings, evidently of saints. There is a small Greek chapel close to the site of the older church, and this gateway still forms the approach. The word Ayasouluk, the name of the village at this spot, has received a good many renderings, but the most probable would seem to be that from "Agios Theologos," and which would also connect it with St. John the Divine. Falkener, in his work on Ephesus, p. 150, gives a statement on the authority of the Greek Synaxaria, that—"The Church of St. John is said to have been built on a hill in old Ephesus." Falkener, with his theory of the site of the temple, could not have supposed that this might have been the Old Castle-hill; but if it should turn out that this is really the remains of St. John's Cathedral, it will form an additional ground for assuming that the original Ephesus stood on this hill, and that the modern village of Ayasouluk stands on the spot where the first colonists founded the city, and to which they were led, according to the tradition, by means of "a fish and a wild boar."

DISCUSSION.

The Chairman said two principal impressions were left on the mind from hearing this interesting paper: first, that it was a painstaking, laborious statement of facts made without any preconceived hypothesis, or any view of supporting an ulterior theory; the second impression was one of regret that the question had been diverted by another explorer to a wrong issue. It was, of course, quite open to any explorer to say, "I have found certain things; they may or may not bear on certain history or tradition, but let us see how they do bear, and find out what their value is." Unfortunately, Dr. Schliemann had reversed the order, and said, "I have found here such and such things," giving them their names, which completely closed the question so far as he was concerned. But, by so doing he opened up a whole array of questions, which those who really wished to know the simple truth must insist upon having answered. Critics, and comparative mythologists, have been for many years past working, not at the bricks and mortar, but at the old traditions, as given in the Homeric poems and Greek plays, and, unfortunately, the general course of their researches had been chiefly in the direction of throwing doubt on the traditions as having any historical value. The comparative mythologist in particular had been accused of taking tradition or history and converting it into sunshine, or moonshine, or talk about the weather, but all that had nothing to do with the question. If these treasuries or tombs were to bear out tradition, they must closely correspond to it. The paper had shown how far the evidence given by these buildings did or did not bear out the old traditions. It was clearly not a straightforward and honest view to take traditions and say, "Here you have accounts of certain buildings; you find remains of old buildings which do not correspond in the least," and then to say that these things which did not correspond with the tradition should be held to uphold that tradition. It was making a large demand on one's faith, to say the least of it, especially when almost every part of the tradition was full of supernatural, incredible, and impossible details for which we had no historical evidence, and of which our only knowledge came from either the Homeric poems, or from the great dramatists and lyric poets of Greece. Then we were confronted with the fact that in the "Iliad," and "Odyssey," we had one account of these supposed events, and in the dramatists and lyric poets we had accounts more or less irreconcilable with these. They were, therefore, much indebted to Mr. Simpson for the perfectly honest way in which he had taken the remains and pointed out how far they did or did not agree with the traditional accounts we possess.

Mr. Jones did not understand that Mr. Simpson made any objection to Dr. Schliemann's account of his discoveries at Mycenæ, including the tomb of Agamemnon, but simply with regard to Troy. In the first place he thought they should be rather careful in finding fault with an absent man, and secondly, it must be remembered that all Europe was paying him homage for what he had done. From Mr. Simpson's description and sketch, it seemed to him that the Agora was very similar to Stonehenge, which he had lately visited, and that the Cyclopean building was very much like the Druidical.

Mr. R. Cust also wished to say a word in favour of the absent. He was present some time ago at a meeting of the Society of Antiquaries, when there were assembled all the wise men of England, and Mr. Gladstone at the head of them, all tendering homage to Dr. Schliemann. And yet now, by a breath, the whole of his theories were to be upset. He had fallen into the hands of a distinguished artist, and a distinguished comparative mythologist—before them all his theories were like a house of cards, and it seemed even to be supposed that he was not honest in his statements. He could only say that anyone who had seen and heard him would believe that he was a most true and honest man. He had devoted his whole life to this work, and therefore he hoped they would not be prejudiced against him without hearing both sides.

Mr. J. T. Wood said he could not pay Mr. Simpson the bad compliment of leaving the room without saying a few words. He did not believe Mr. Simpson meant to assail Dr. Schliemann as had been supposed; but he was perfectly justified in saying honestly what he thought. He (Mr. Wood) had a high opinion of Dr. Schliemann, having known him before he commenced his excavations, and he consequently came to see him at Ephesus, congratulated him on his success, and consulted him as to the possibility of getting a firman from the Turks for excavating in the Troad. He would not touch on Dr. Schliemann's discoveries, because there were many questions yet unsettled; but there was one ethnological fact he had not mentioned with regard to the present inhabitants of Troad. He rode one day from the Lower Troad, where a friend of his was employing about 100 workmen in excavating the temple them, and went towards Hissarlik, where he put up at a of Apollo, all fine, handsome men, six feet high most of café. There he found that he came in contact with quite a different population; short, hump-backed, and ill-

tempered. He had been wondering whether those were fair specimens of the ancient inhabitants, because, if so, the grand heroes of Homer were not equal to those of the present day. Coming to his own explorations, Mr. Simpson had mentioned that one sculptured drum had been found, but the fact was there were fragments of five. Unfortunately, the museum had not room to contain all the stones from the temple, but there were certainly hundreds of inscriptions there. As regards the mountains, he had ventured to change the names, because it was quite evident from inscriptions that the one called Mount Prion must be Coressus, and *vice versa*. He found in the walls of the temple an attempt to build a church by the early Christians, which probably was intended to be the church of St. John. The foundation piers had been raised to 13 ft. high, and then an earthquake came and toppled some of them over, and raised the ancient pavement four or five feet above the original level, upon which the Christians evidently abandoned the site, for in one place there was a heap of mortar which had been left there when the work was interrupted. They then seemed to have altered their plan of building it on the plain, and built it on the hill. There were remains of a church found there, and over those remains was a modern church, where service was attended every Sunday and saint's day by the modern Greeks. He must say he differed from Mr. Simpson as to the site of ancient Ephesus, and was strongly opposed to his theory, because there were no signs of an ancient city there; whereas traces of old walls were found on the other side of the plain. He should be sorry for the audience to go away with the idea that it was no use going to see the site of the ancient temple, because the stones had been removed, and it was filled with water. The water rose in March, and that was his chief difficulty, but in the autumn it subsided to the level of the pavement, and in the winter months it was very low. Then was his opportunity for exploring the temple to a lower depth. In conclusion, he would say that Dr. Schliemann was exceedingly enthusiastic, and he believed perfectly honest, but honest men would make mistakes, especially when they were very enthusiastic.

Mr. Simpson, in reply, said it was not his fault that Dr. Schliemann was absent. He made all the statements he had now made in an article published in *Frazer* in June last, to which he signed his name. He had simply stated what he had seen, and a good deal of it became a question of credibility. He did not attack Dr. Schliemann's honesty, but he questioned some of the facts stated in his book; and he would especially refer his hearers to plan 2, at the end of "Troy and its Remains," the plans at pp. 306 and 347, and the drawing of the Palace of Priam. He had nothing to do with the great authorities who honoured Dr. Schliemann; he could only say what he saw. Other people would, no doubt, go there and report what they found, and thus the question would be settled. He had no doubt, in his own mind, that Dr. Schliemann's enthusiasm had carried him away.

The Chairman then proposed a vote of thanks to Mr. Simpson, which was carried unanimously.

NATIONAL WATER SUPPLY CONGRESS.

The proceedings of this Congress commenced on Tuesday, the 21st May, the chair being taken by Sir Henry Cole, K.C.B., in the unavoidable absence of Sir Ughtred Kay-Shuttleworth, Bart., M.P.

The Chairman, having expressed his regret at the absence of Sir U. K. Shuttleworth, said he entirely agreed in the outline of the suggestions made by the President of the Society. Though he was no engineer, he knew what pure water was, and during the last two or three years he had been in several towns, where he had investigated what the authorities did for the water. At Manchester they had the filthiest river water in all England, and if a man fell into the River Medlock he was not drowned, but suffocated, and that was pretty much the state of most of the rivers in Lancashire and Yorkshire; but many towns had taken very effective measures for supplying their people with pure water for drinking purposes. The water at Manchester was so pure that people gave up drinking wine and became teetotallers, because it was so much pleasanter to drink. It was pure, soft, and cool, and you could have as much as you liked; in fact, compared with Manchester, London was at the lowest point of civilisation in this respect. Manchester was now endeavouring to make a further provision for her population, and on the authority of Mr. Bateman they thought they could get a sufficient water supply from Thirlmere. It was a matter for rejoicing that a large town with unlimited command of capital had been able to hit on a scheme of that kind. Gentlemen who liked the picturesque fancied they were going to be damaged, but they used to fancy the same thing with regard to railways, whereas it was obvious to those who looked at railways in their construction, that there were many places where, if viaducts were graceful, they really added to the picturesqueness of the view. It was a pleasing sentiment, no doubt, to have nothing touched, but it was a great deal more important to have pure water for the people. It had been proved before a committee of the House of Commons that Manchester could get this pure water from Thirlmere, and was not unwilling to expend £4,000,000 in getting it. But while Manchester was providing for its own population, and bringing this water 100 miles, he should have liked to have seen the question so extended, that the same scheme might really supply the whole of the northern counties. There was a great deal more water in the lakes, if they were treated on a large scale, than the whole of England was likely to want, and what was being done for Manchester, and, by the direction of the Committee of the House of Commons, was to be done for the towns that adjoined that great aqueduct, might by an extended scheme be done by a local commission, or something of that kind, which should not look after Manchester only, but after the whole of the northern counties. He had been personally interested in the water supply of Birmingham. That was not the best supplied place, and had not an adequate supply, but the conviction in his mind was that it would be quite possible to draw a supply from the lakes which would supply Birmingham, and even come up to London if necessary. In Birmingham they got it as best they could, from the sandstone in the neighbourhood, and it was pretty fair, but the greater part was from wells very near to cesspools, and the people were poisoned, as might be expected. If they accepted the facts stated as to the rainfalls of this country, there was many times as much water running to waste as was required, which might, in some way, be stored for the benefit of the people. He saw many gentlemen present who knew perfectly well how water was to be collected, and the conclusion he had come to as an unscientific man was that you might divide England into a sort of heptarchy, having six, seven, or eight great sources of water supply. You might bring it from the rivers before the water was polluted, and in certain cases might get it out of the earth. Engineers would know perfectly well how to get it; and the State ought to say that everybody is as much entitled to pure water, as he was entitled not to be poisoned by bad air. If that principle were affirmed, with the facts already collected, the Government might appoint an authority which should devise a scheme for supplying the whole country. He would not go into details, but thousands of years ago nations knew how to make reservoirs and aqueducts, and supply their people with pure water; and what

was done then might be done now. The heavens poured down water, which flowed into the sea, and if we could only preserve it, there would be abundant supplies, but so long as you left different places to get what they could on a little peddling scale, the great part of the work was left undone because there was no co-operatiom. He did not want too much centralisation, but just so much co-operation as would enable you to get at the sources of water; and when you had done that, and got reservoirs, and made aqueducts, then leave every separate locality to obtain the water it wanted, and was willing to pay for. Before going any further, it would be as well to read what the Prince of Wales had said in his letter. Having done so, the Chairman said there was no doubt that these suggestions of the Prince were of the greatest national importance. If, instead of sending our capital out of this country, with the chance of getting it back very small in some cases, if it were to cost £100,000,000 or £200,000,000 to ensure the population being adequately supplied with water, it would pay extremely well, and he had very little doubt that Government would be able to manage the finances in such a way—calling in the assistance of great engineers throughout the country, and leaving them to devise a scheme in each district which would meet its requirements, and giving a guarantee of moderate interest—that, he believed, the plan would pay both commercially, and much more economically, in improving the health and prosperity of the country.

The Chairman then invited the Congress to discuss the subjects on the agenda paper, beginning first with the national sources of water supply.

Mr. G. J. Symons, having read the paper which he had sent in, went on to say that he was pleased to hear from Sir Henry Cole that he thought, as he did, that it was a great pity to treat this water question on a small plan. If one thing commended itself to his mind more than another, it was the great desirability that our large supplies, which would yearly yield enormous quantities if properly treated, should not be voted away to the first town that agreed with the landowners of the district, but that each great gathering-ground ought to be treated as a whole. It was not for him to enter on the Thirlmere question, but, as it had been raised, he could not help saying that he thought it would be a great pity to take it away from the general treatment of the other lakes. Any engineer who would go carefully into the question would say that, looked at from a national point of view, the right thing would he to treat these three lakes as one enormous supply—a supply, not merely for Lancashire and Yorkshire, or Birmingham, but for the whole kingdom. There was a large population in one district with a very small rainfall, and a large rainfall in another district with a very small population, and all they had to do was to bring the one to the other.

Mr. Joseph Lucas, F.G.S., said that the paper he had sent in was divided into three heads:—"What the difficulty is," "What has been done to meet it," and "What remains to be done." But he had purposely avoided raising the fourth question, as to "Who should do it?" because he was not sure whether, assuming the Government survey of the water supply were carried out, it would be the province of that Congress to discuss what particular department of Government should take it up. He would not trouble the meeting by reading what was already printed, but would call attention to a particular kind of map which he had been able to produce after observing the variations in the levels of water in wells, the result forming only a small part of that whole survey which ought to be carried out if Government took up the matter. There was a great want of knowledge of the position of the boundaries of the underground watersheds, particularly in the chalk, and this was what he had paid attention to. He would refer to the watershed boundary between the Thames and Hampshire basins. Previous to his own survey of that part of the country, there was no possible means of determining the watershed between these basins, and a good deal might turn on that, and in fact a good deal had turned lately on a knowledge of the underground water-shed ridges, separating the basins of the Wandle, the Ravensbourne, the Cray and the Darent. It was very unlikely that anyone besides himself would be acquainted with the precise position of all these boundaries. Between the Darent and the Medway, there were two intermediate underground basins divided by no natural boundary on the surface whatever. He did not feel called upon to make any suggestion as to the means to be adopted for utilising the water in this formation, but it was evident here was a volume of water whose shape was defined on these maps, and anyone by looking at the map could form a fair idea of the volume of water in the chalk. Before the construction of the map, the shape of the water system was not known, and contrasting the part mapped with that not mapped, it showed the truth of what he was saying with respect to the underground water-shed basins. He was, therefore, of opinion that all the water-bearing strata should be surveyed for the use of engineers and those interested in extracting water. Another point of great importance had also come under his notice, namely, the utilisation of all the available sites for reservoirs which were scattered about the country. The counties of Surrey and Hampshire were distinguished by a number of large ponds which appeared all to have had the same origin, and to have been made for the same purpose. They all appeared to be of ecclesiastical origin, to be very old, and to have been made originally as fish-ponds. They had stood for hundreds of years practically useless, and one very striking reflection which occurred to him was, that if anyone now wished to construct these ponds for the purpose of water supply, it was very questionable whether they could do so, because every species of opposition which could be raised up against them would be aroused. Now, if they were utilised for the purpose of water supply, and the number were increased, a good deal of the present difficulty in respect of country places would vanish. Something had been said about their want of purity, but he could only say that a large number of noblemen's and gentlemen's houses were dependent on similar sources. It was certain that sites of that kind abounded in the country and many of the old fish ponds which were falling into disrepair were capable of being enlarged and utilised. A good instance occurred to him in the Heath-pond, at Petersfield. The union of such a survey as that conducted by Mr. Symons with a survey of the water in the strata, upon which certainly not less than two-thirds of England was dependent, was very desirable, because without such a survey showing by certain lines the shape of the water systems, no direct evidence as to quantity could be forthcoming; but by putting together Mr. Symons' survey, and such a one as his own, this information would be obtained. He had particularly treated that point in the explanation of the second sheet of his map which was just published. These maps were designed to show at a glance the presence or absence of water in the rocks which outcropped at the surface of the earth. Having referred to the concluding paragraph of his paper, he said that the stimulus which the measures there recommended would give to engineering work was undoubted. There had been Bills in Parliament this year which had taken their origin in the public interest created on the subject by the reading of certain papers, and by the publication of these maps. In the district where he lived, at Tooting, there was a remarkable series of artesian wells—at least 116 in the valley of the Wandle—still overflowing. There had been a little water Bill introduced into the House of Commons this year, but it was dropped; it seemed to have been rather put out as a feeler by another body,

not the nominal promoters, to see what opposition would be raised to a proposal to sink a large artesian well so near to London. The little opposition which was aroused was quite sufficient for the occasion. He had reason to suppose that in all probability another session would find the Tooting district put down amongst a number of sites which the Metropolitan Board of Works intended to invade. He merely introduced that in order to show that, in artesian areas, the pure water raised by borings to the surface should be left in the possession of those who had it, and should not be subject to the decision of a committee, which could not possibly have the necessary data to pronounce on the propriety of such a supply being taken away, without a proper hydrogeological survey.

The **Rev. J. C. Clutterbuck** said the few remarks he wished to make were based on two or three statements which appeared in the first part of the paper he had sent in. He fully recognised the value of Mr. Symons's great labours in reference to rainfall, but this question involved the necessity of an extended and accurate knowledge of all water supply, namely, the amount of rainfall throughout England, and the quantities of water which in various localities were available for supply, either by artificial or natural storage, whether on the surface, or by absorption in the various strata of which the country is composed. He also begged to call attention to this—that the question of water supply had its limits, varying in times and seasons, and must be more accurately ascertained than it was at present. He was quite sure, from his experience, that the amount of the yield of rivers was over-estimated, and it must be borne in mind that the only real test of the rainfall of any district was the volume of streams and rivers, which were the natural gauge of the quantities available for use. A great deal had been said about the lake district. He did not know very much about that, although he had resided there at one time for a considerable period; but he had noticed that when there was a large rainfall, almost the whole of it passed off in the form of floods. If he went into Wales, where there were the same geological conditions, when there came a heavy storm of rain in the night, the stream which he had seen reduced to a mere thread the day before, was increased to a torrent; but two days afterwards he found it again reduced. Therefore the conclusion he came to was that there was no subterranean storage which could be relied upon, either in the lake district or in Wales. He knew this was a bold assertion, but still he made it with a full conviction of its truth. There was a gentleman present, who, with those who preceded him, had carried on a system, which might be called his own, of gauging the rainfall. It might be traced back to the great Dalton, who constructed a rain gauge by which he was able to estimate the amount of rain which reached what was commonly called the springs, but what he should call the water level in the chalk. It had been found that the quantity of water which fell on the surface was very much in excess of that which reached the subterranean reservoirs, about three times the quantity, and he held it to be an incontrovertible fact that the only gauge of the quantity of water which could be reckoned upon, although of course it was ruled by the quantity of water falling on the surface, must be considered with reference to the constitution of the soil on which it fell, the capability of the soil for appropriating it by its passage down to the lower strata in which it accumulated, as in a reservoir. He was not aware that in any of these reports made with reference to Thirlmere, any reference was made to the gauging of rivers, or any absolute proof that the quantity of water which was relied upon would ever come to the surface of the ground; and he should be sorry to think that that Congress should be led away with the idea that the quantity of water available was limited.

Mr. Edwin Chadwick, C.B., thought it would be well, before going further into a discussion of what the Government ought to do, to have a little more precise information as to what was already done, and how far it subserved the present object. It seemed to have been quite lost sight of that there had been a geological survey carried on throughout the whole country, with great skill and scientific accuracy, one of the best surveys that had been made, and that related to the geological surface, and to the water-bearing strata. He knew that besides what might appear on the surface of the map there was a good deal of collateral information in possession of the department as to other points, such as the quantity of water-bearing strata. Probably there was a great deal yet to be done, and he should submit that one of the first things to do would be to inquire of Professor Ramsay, or the other gentlemen conducting the survey, how much they had already done, and what more they might do, because it was quite possible they might themselves suggest additional borings and other information beyond the important geological survey which they had carried out; but undoubtedly that survey was a great and successful work so far as it went, and was very subservient to the objects in view. He could only say that engineers did practically make use of it, and had no difficulty in obtaining a great deal of information of which they commonly made use, without acknowledging the source from which they obtained it.

Mr. F. R. Conder, C.E., said the beautiful plans on the walls indicated that they might presently get into the region of controversy, but they had not done so yet, and they seemed all to agree on the main points put forward by the Chairman. No one could have paid any attention to the subject of water supply without coming to the conclusion that the title of a national benefactor was due to Mr. Symons, who had gone far to redeem this country from the stigma which might be thrown upon it for its unscientific mode of dealing with the water supply. Again, Mr. Lucas had given an example of very patient and exhaustive individual inquiry, and Mr. Clutterbuck's and Mr. Chadwick's remarks all tended to the same point. He wished, therefore, to ask whether it was competent to anyone to propose a resolution; because he thought if they could pass some resolution on which they were all unanimous, it would carry great weight with it.

The **Chairman** thought it was too soon yet to propose any resolutions, though it might be the opinion of the meeting to-morrow that certain points seemed so clear that it would be only fair and right to put them in the form of resolutions.

Mr. Conder said he quite agreed with that view. Hitherto they had had individual opinions brought forward by men who deserved every respect, and he thought it would be wise to see how far those different opinions, instead of being opposed to one another, might be brought to one point. Mr. Symons gave the actual measurement of the water which fell in the country, and they wanted to know what became of it. Mr. Clutterbuck said they must gauge the rivers, and that between the result of that gauging and the rainfall there was a great loss. Now they wanted to know what that loss was. Mr. Chadwick had justly said that the Geological Survey would give aid in answering that question. By thus bringing together the different sources of information, they would be able to see where it was necessary to acquire more observations. On that point they had the example of foreign communities, more especially Italy. He really thought that the mode in which the Italian Minister of Public Works had set himself to grapple with the great subject of the hydrography of Italy, in which he had endeavoured to ascertain what rain descended, what became of it, and what was necessary in order to keep the rivers in a proper state; in short, to bring the whole thing so clearly on the table that the engineer might with perfect ease undertake whatever work was before

him, was one highly deserving of imitation. Until something of that kind was done, they were all working in the dark; and it was evident that, in this great inquiry, they needed the assistance of many branches of the profession. The topographical map, which must form the basis of the survey, had been prepared in a mode of which they might justly be proud in the Ordnance Survey; and the Geological Survey was no doubt following in the same steps. To that they ought to add special inquiries as to the water below the surface, such as Mr. Lucas had pointed out. The combination of every effort of this kind, and the necessity of having some general plan to which every scientific man might contribute, and to which they might all go to draw whatever information they wanted, was, he thought, the great object they should keep in view.

Dr. Gilbert Child said he felt some difficulty in dealing with this question according to the arrangement laid down, because there were certain questions as to policy, modes of government, and so on, which would come almost equally under two divisions; but the short paper he had sent in belonged more properly to the second part, and he would, therefore, not deal with that at present. Mr. Symons had said something about the perpetuity of our legislation; but, on looking into the Public Health Act, he found that when it was passed, in 1875, it repealed about 24 Acts, the oldest of which was 26 years old. That seemed to be a very remarkable specimen of perpetuity. At present, they seemed very much enamoured of local government, but this local government did not seem able to grapple with our water resources. Mr. Symons referred to that point, and said that the watersheds were the proper divisions, and with that they should all agree to a certain extent; but, at the present moment, they must remember that the water sources depended on the watersheds and geological formations, and that our local government divisions had regard only to townships and parishes. Now, nature cared uncommonly little for divisions of that kind, and therefore they must be prepared to give up that insane mania for local government to some extent, not making a great revolution and centralising everything, but introducing different arrangements. He was extremely glad to see the unanimity which upon that point had pervaded the Congress, that there should be some organisation corresponding to the Ordnance Survey and the Geological Survey, which should really bring before the local bodies, before they acted, the means by which they might act, and the resources with which they had to deal. But before they could apply that to any good purpose, the Government of the country must take it up, and in some way put the rights of local government bodies in accordance with the resources which nature pointed out. You now had a little village in one place, and another in another, on two opposite sides of the same stream, and they dealt with the question of water supply and drainage not the least in harmony with one another. The natural resources they had were very likely the same, but the mode in which they dealt with them might be quite different, depending very often on the wishes of some particular local magnate. The primary consideration with regard to these questions must be that of economy, for the main thing to consider was, how you could give an adequate supply of pure water on the most economical terms; and, taking tho county with which he was most intimately acquainted, it seemed impossible to him, where you got villages on the oolite formation, with streams and springs in great number, and in another part a great mass of Oxford clay, where there was no water at all, or if there was, it was totally unfit to drink, and then, again, at the top of the Chiltern Hills you got miles of chalk, where the water was 400 feet below the surface, that the same mechanical appliances should be used to supply the various populations existing under such totally different conditions. A great deal had been said about the subterranean water supply, and he hoped that question would be always studied closely in relation with the one with which Mr. Symons dealt, namely the rainfall, because whatever the subterranean supply was, it must depend on the rainfall. Some persons talked about the subterranean water supply as a young man who had just come into his property talked about the balance at his banker's, and seemed to think you could draw unlimited cheques, and the supply in the subterranean strata would answer all demands. He could not help thinking that that would turn out to be an enormous fallacy if ever it was tested. The great point which he hoped would take form of a resolution was, that before the water supply could be dealt with in a manner worthy of a great nation, it must be dealt with by means of some organisation resembling that of the Geological Survey, and taking into account the labours of that survey and of the Ordnance Survey, that it must be done over the surface of the country as a whole, and should not be left in the hands of parishes and townships.

Mr. Williams (Liverpool) thought the great outline of the question, which was to govern the future, had been shadowed out by the Chairman and followed up by Mr. Symons. There was no doubt that at the present time there was a great scarcity of water, and even where it was supplied it was not of good quality; in fact, speaking of it as a whole, it was poisonous. In looking through the Parliamentary Blue-books, his idea was that upland waters were, as a whole, the best. Therefore, the waters in the North of England and in Wales should be brought under control, and compelled to render service to man before they fell into the rivers and went off into the sea. As the matter stood at present, it seemed as if these rivers were a parcel of mad horses tearing away, causing great destruction, knocking over railways, and overflowing agricultural districts, iustead of doing great good to man; and he hoped the object of this meeting would be to put a bit in the mouth of every animal, and bring it under control, and compel these waters to render service before finding their way into the sea. The best waters undoubtedly were those described as upland waters, which fell on the highest rocks, and found their way into the lakes; but, by reason of these lakes being so far distant, they might as well be in India for any service they were. Even this great metropolis, although it was fully aware that the best waters were in the north, dared not look in that direction. It appeared to him that the problem was to be solved by the Government, and by that only. In glancing over some of the papers he held in his hand, the problem appeared to him to be very easy of solution. Supposing the Government were to take the matter in hand for some local body, a rate of 1d. per £ on the property and income-tax would yield £2,000,000 per annum, which, at 4 per cent., would pay interest of £50,000,000. Now, that was a large sum of money, and would go a very great way in making aqueducts and engineering works for bringing of these waters from Wales and the northern lakes, by four or five lines, to given centres; and, by bringing the lakes near enough to the great centres of population, the whole question would be solved. Without being an engineer, or pretending to clothe himself with any authority at all in the matter, simply by the use of common sense, he thought that before 50 millions of money had been expended it would be found that these waters could be brought sufficiently near for any centre of population to go for it, and the centre, middle and end of the duty of the Government ought to be simply to bring the water to some given centres near enough for the great populations to supply themselves. That would at once do away with exceptional legislation, and there would be none of these contests which now took place, and which cost so much money, like the recent battle in Manchester, or that one fought in Liverpool,

where over £30,000 was expended, mostly among the lawyers. Liverpool was now again putting on its armour for another water supply contest; and therefore he hoped that the Government would take the matter up and deal with it in a comprehensive spirit.

Mr. W. Shelford wished to say a word or two in support of what he understood to be Mr. Lucas's proposal, that an hydrogeological survey should be made. He spoke from some experience, because he had been engaged in works of water supply as an engineer, and more recently in the investigations for the Metropolis Water Supply Bill, which included the particular district to which Mr. Lucas referred, where a proper hydrogeological survey would have been of great service to himself and other engineers engaged in that investigation. He was not at liberty to go into that question, but he might refer to another district precisely analogous, namely, the chalk in Lincolnshire wolds and the district between that and the sea. It had been his lot to sink a line of wells from the chalk down to the sea, 13 in all. In some of these the water was 100 feet below the surface, some were artesian, and in some the water rose and fell with the sea, and by this means he had been able to get the hydrostatic level of the water from the chalk to the sea; and he had been able to prove, beyond a doubt, that there was a subterranean stream of water from the wolds to the sea; that it escaped to the sea in a hole shown on the chart of the North Sea some miles in length and of great depth, which was no doubt caused and kept open by waters from the chalk in the Lincolnshire wolds. This was a startling fact when it first came to his knowledge. Engineers had been in the habit of gauging springs from the chalk, and assuming that the difference between the rainfall which they represented and the actual rainfall was dispersed in evaporation, but it was certain that there was often another outlet for the water, that it did not all go in evaporation, but that there was a considerable subterranean stream into the sea.

Dr. Bond wished to call attention to a suggestion made by a former speaker, which seemed to him of great importance, namely, that the outcome of this meeting should be a practical one. They were met to promote action, for it was only in such a way that action could be promoted in sanitary matters, namely, by combining those who had experience in the subject with a view to epitomising, as far as possible, every point of agreement, and putting them before the sanitary authorities, and he ventured to suggest that it would be desirable for the secretary, with the assistance of the Chairman, to prepare for the consideration of the meeting to-morrow one or more resolutions, which might appear to embody the general sense of the meeting upon the points upon which there was an approach to unanimity, for instance, on the great question of the want of information. What they required was the fullest possible amount of information on the water resources of the country, and when that was obtained they would be in a position to go to the Government for legislative action. He would suggest that there was an analogous case in the matter of the charity resources of the country, with regard to which a permanent Commission had been appointed, whose function it was to take cognisance of all charitable bequests, to initiate and promote legislation upon them in a variety of ways, and to deal with them in such a way that they should be utilised for the public benefit to the largest possible extent. It seemed to him that they wanted something of the same kind with reference to the water supply. They had had a temporary Commission on Rivers Pollution which had done admirable work, and they wanted a permanent Commission with large powers for obtaining information and promoting legislation, in fact, to take charge of that great department of local self-government. It was a work which could not be done by the Government itself, which was frequently changing, but could only be initiated by a permanent body of that kind.

Mr. De Rance next read the paper which he had contributed.

Mr. John Evans, D.C.L., F.R.S., F.G.L., then read the paper which he had sent in, and also added the following remarks. With regard to the amount of rain which has fallen over any given district, it would be found by calculation, that allowing 30 gallons per diem to each person, the rainfall of four inches over one square mile would provide sufficient water for 5,120 persons. If that rainfall were increased to 20 inches, then it would be available as a sufficient daily supply for 25,000 persons. Taking the area of the Ulleswater district at 100 miles, it would appear that with 20 inches rainfall there would be a sufficient quantity of water for 25,000 persons, but that was assuming that the 20 inches could be gathered and conveyed away. They must not, therefore, go away with the idea that the mere limited descent in the lake country, or in any part where there was a large rainfall on hard rocks, afforded an unlimited supply, from which the whole country might draw. The unfairness of the present method of rating had been brought home to him by a scheme in the country to which he had placed his name. He was immediately attacked by the occupier of a mill, who resided at a distance of about two miles from the area to be supplied with water, who wished to know what he had done that he should be taxed £35 a year for water which he did not want. He said he would not object to his premises being taxed if they were land, the same as the property of the neighbouring farmers, but it appeared very hard that property at a distance should be taxed in that manner at its full value, when practically it derived so little benefit from the mode in which the money was laid out. In order to meet that difficulty it seemed to him not only that they should have in each district some central body to which questions relating to water supply might be referred, but there should also be in operation in the country some kind of building Act like there was in the larger towns, by which persons were prevented from building houses on sites utterly unfit for human habitation, and totally regardless of water supply and drainage. He should be glad to see the day when we were governed more by a general feeling for the good of the country than we are at present; but he believed that any such Act would be so unpopular, that either the Liberal or Tory Government would be perfectly afraid of introducing it. Such, perhaps, might eventually be brought about, and in that case a great deal of the evils arising from limited water supply and bad drainage in country districts would be obviated.

Mr. Walter Pierce then read portions of the paper which he had prepared, and added, with regard to the second paragraph, that one gentleman had recommended that a permanent Commission should be appointed for further inquiry, both as regards the question where an abundant supply of water could be obtained, and also whether there was an abundant rainfall, so as to make certain that the supply could always be obtained. It appeared to him that the Government had already done a great deal in this way, for on looking through the Blue-book, it would be found that almost every point they could suggest with reference to this question of water supply, had been in some measure touched upon by the Royal Commissioners, so that really it was not a question of where they could get the water from, or what might be the rainfall, but how it was to be obtained. He also added some further remarks to those he had printed with regard to the great evils arising from too great economy being insisted upon in the use of the water, particularly where it went the length of putting up stand-pipes to supply a number of houses, instead of bringing the water into each house. In the case of the aged and infirm it was a great hardship; and what they should aim

at was to give an abundant supply of water in every dwelling, so that the requirements of cleanliness could be thoroughly provided for.

The Congress here adjourned for luncheon. On resuming,

Mr. Shoolbred said he desired to make a few remarks before the first subject was concluded. Mr. Symons had suggested that the rainfall would remain probably the same in the future as it was at present, but he had had an opportunity of residing abroad, in some countries where the rainfall had been found to vary considerably, mainly owing to the cutting down of forests. Such a thing might happen here, although we had not such extensive forests, but so fully alive were they to the disastrous effect of this process, that in some parts they were absolutely planting on a large scale, in order to endeavour to recall a portion of the rainfall which they had lost. With regard to the subject generally, it was evidently the desire of the Prince of Wales, from his letter, and of many present, that the country should be mapped out more distinctly, according to its natural features; and that those smaller towns which were, unfortunately, not in a position to cope with their larger neighbours, should not be deprived of what were their natural rights. In dealing with that question, the natural mode seemed to be indicated by Nature itself, in the laws of gravity. He thought, therefore, that the natural district for water authority should be the watershed. Several suggestions had been made with regard to the governing bodies, or controlling power in a district of that kind, but one point seemed to have been a little overlooked, namely, the difficulty of the present law. In small towns the power of the Vestries and the ratepayers was often exercised in a very injurious way; and it prevented improvements, which were very much needed, and which the wealthier inhabitants of the town would willingly have introduced at their own sole cost, but which, owing to the peculiarity of the law, these small ratepayers, who would not have been called upon to spend one penny on the improvement, had year by year prevented.

Dr. Wright (Cheltenham) said the last speaker was under a mistake if he thought that Nature by herself would always do justice to the various parties. In fact, to the town to which he belonged, Nature had behaved very badly, for they had nothing like the amount of rain which belonged to them. They were robbed of it by the London people, and when they wanted to take a small portion of what belonged to them, the whole district was up in arms against these public robbers, as they were called. Cheltenham lay near the base of the Cotswold Hills, which ran in a north-easterly and south-westerly direction accross England. The water supply was, of course, from the rainfall. The geological formation of those hills consisted of the inferior oolite which rested on the great lias formation. The oolite rock took up the rainfall like an enormous absorbent sponge, and retained it until the hills became, so to speak, a complete rocky reservoir of water, which was given out in springs escaping at the line of junction between the oolite and the lias; but it so happened that Nature had inclined those beds a little to the eastward, the dip being about 2 deg. or 3 deg.; and it was just that dip which took away the rain, which belonged to Cheltenham, from the west side of the hills to the east side of the lias area, where it fell into the Thames Valley. Hence it was that they complained most bitterly that they could not have what nature had duly apportioned to them. It was not only that the large towns of Gloucester and Cheltenham, and other towns in the valley, were deprived of their natural supply, but there was a great dearth of water all along that valley of Gloucester, all arising from this same cause. These were matters that ought to be considered in dealing with such a question, and no doubt the views which would come from such a meeting would lead to some practical result, but the question as it now stood was an extremely difficult one. He had studied it for many years, and did not see how to grapple with it at present, there were so many contending interests to deal with. He did not say it ought not to be grappled with, for there was nothing more important; but how to approach it, and so meet the practical difficulty such as he had indicated, he did not at present see. Whether means could be taken for storing up the storm-waters of those hills in convenient situations, in large reservoirs in the long valleys that were formed by Nature, was a point which had often occurred to him as a solution; but they could not expect rural populations to do these things for themselves. They knew how the agricultural interest protected itself, and how difficult it was to get rural sanitary authorities to do anything for the poorer districts. In some parts they had no water supply at all, and could only catch that which ran down from the hills, and let it settle. The Winchcomb Union had thrown the duty of getting a water supply on the owners of the property along the western slopes, telling them they must dig wells, when, in fact, there was no water there, for it was only found along the line of drainage from the oolite to the lias; therefore, unless it was taken up by sanitary authorities, it never could be done. The question was one which opened out a vast subject for investigation, and he hoped the ideas that would flow from this course would lead to some practical good, but the difficulties were very great.

Mr. Shelford asked leave to refer to an expression made use of in his Royal Highness' letter, namely, the "varying specialities and wants of districts," which, he thought, was a particularly happy expression, because it not only included the variations which occurred in the trades, occupations, and other circumstances as between one district and another, but also included that ceaseless variation which was going on in each separate district. He might illustrate this by showing the changes which had taken place within the last few years in the metropolis itself, as appeared by some maps which he had hung on the wall. The first map, indicating the condition of the population in 1871, showed that the most densely populated part of London was Marylebone, Holborn, and Whitechapel, and to the north and east of the City, the population there being about 237 per acre. The least dense was at Lewisham, where it was 1 to the acre, the average population being 43. The next map showed the increase of population which had taken place between 1851 and 1871, by which it would be seen that, during that 20 years, there had been an average decrease in the population of the City of 54 per cent., whilst in Battersea there had been an increase of 260 per cent. At Plumstead a large increase had taken place, and also at Sydenham, Norwood, and Kensington. During that period there had been a considerable development of suburban railroads, which had altered the conditions of life altogether. The third map showed the increase of rateable value during the 20 years. With the exception of two small spots in Aldgate and the Temple, the whole of London had increased in value, the maximum increase being in Kensington, where it was 424 per cent. There was also a considerable increase in Dulwich, Hampstead, Lee, Penge, and Bow. The maximum decrease had been 16 per cent. in the Temple only, and that perhaps might be accounted for by some exceptional circumstances with which he was not acquainted. The average increase on the whole was 104 per cent. In relation to the water supply, the practical result was, that the work to be done by the metropolitan companies, or whoever supplied water to London, had increased in the ratio of the population, viz., 34 per cent. in the last 20 years, whilst the source of revenue had increased on the average 104 per cent. or three times as much.

The Chairman then said it was time to pass to the second head of discussion, namely, the means of supplying towns and villages, excluding London, and he would

call on Mr. A. H. Brown, M.P., who had charge of the Bill dealing with this subject, to address the Congress.

Mr. A. H. Brown then proceeded to read the paper he had contributed.

Dr. Gilbert Child, after expressing his high opinion of the paper read by Mr. Brown, said that all who had had to deal with the carrying out of the Public Health Act of 1872 and 1875, must have found that there were two classes of difficulties in the matter, and Mr. Brown's Bill really dealt with one of those, but not with the other. The class of difficulties with which the Bill dealt, and as it appeared to him very efficiently, was that of the actual gaps and chasms in the powers granted by the law up to the present time to rural sanitary authorities. Those authorities, anxious as they might be to supply their districts with water, had found immense difficulties in the way, and these difficulties were, he believed, dealt with most efficiently by this Bill. But there was another point. It was not enough to supply sanitary authorities with power to do certain things so long as they had no will nor desire to do them. Now, this Bill of Mr. Brown's, though good in other respects, did not touch that administrative question at all. It was to this point he had specially addressed himself in his printed remarks, where he referred to the unsatisfactory character of permissive legislation; and he could not conceive how this sort of thing had gone on in the way it had. It was perfectly intelligible that in certain instances permissive legislation might answer its purpose admirably. The kind of permissive legislation which allowed a railway company to take lands for certain purposes would work, because the very existence of the railway company depended on its being able to get the lands; but if you pass a law by which you permitted A, B, and C to put themselves to a considerable amount of trouble for the purpose of conferring a benefit on D, E, and F, at the expense not of D, E, and F, but mainly of A, B, and C, how could you expect ever to get it done? Did the experience of those who had personally to deal with this matter in large districts show that it was at at all likely to be done? He could not say that it was; and he regretted to say that he could not see how Mr. Brown's Bill would help in the matter, because it left that matter alone altogether, and he could quite understand why. He further observed that if you looked at the Public Health Act as it stood, it would be evident to everybody that the difficulty he just mentioned was one which anybody could see would occur, and he believed the Act as it stood was intended to provide for that difficulty, and that was the history of the part of that Act which gave power to the Local Government Board to deal with the matter. He would not detain the Conference by detailing the various boundaries of Local Government districts for different purposes. All these things everybody who had dealt with these kind of matters practically knew formed one of the greatest difficulties to be got over, but he could not help seeing that in the Bill for establishing county boards, which was at present before Parliament, there was practically speaking the creation of one more of those innumerable jurisdictions which would, as far as he could see, render the present confusion worse than it was. To recur to his former point, permissive legislation as it existed for this purpose was a failure, and there was no earthly reason to suppose it would ever be a success. He believed this was fully foreseen when the Public Health Act was passed, and he would ask the Conference to consider whether a merely legislative remedy was likely to be successful in eradicating that which was an administrative disease in a great measure, it being seen perfectly well that permissive legislation would not work by itself. It was intentionally and carefully limited in the Act of 1875, by the establishment of a Local Government Board, for the purpose of seeing that the main objects of the Bill should not be defeated by the unwillingness of local bodies to carry them out. That power did exist, and as far as the words of the Act went, with sufficient cogency, but, as a matter of fact, the Local Government Board systematically refused to put it in action. The 299th clause was the one most frequently quoted, beginning with the words "Where complaint is made," and it was argued unless complaint was made, the Local Government Board could not act; not only so, but carrying out the great rule how not to do it as completely as possible, that had been expanded to this point, that complaints made by the officers of the Board were not treated as complaints within the meaning of that section. For his own part, he could not see why the words should not be interpreted to include complaints made by officers under the Board, who were the persons most fit generally speaking to make complaints. However, such was the case, and if clause 299 stood alone, there might be something to be said for it; but there was another clause (the 293rd) which stood thus—"The Local Government Board may cause to be made such inquiries as they see fit, in relation to any matter concerning the Public Health Act, in any place." He would ask the meeting if it was possible to conceive more general or more sweeping words than those; yet, somehow or other, everybody who had to do with this matter, could give instances in which the most glaring cases of bad water supply, which had been proved over and over again to be injurious to health, had been reported to the sanitary authority but had not been acted on; which had then been handed up to the Local Government Board, and had not been acted upon; and that had gone on year after year, so that the whole object of the Bill had been defeated by the action of that very authority which was the very mainspring of the whole apparatus. In order to show that he was not speaking at random, he would refer to a case published in the *Sanitary Record* for last week, regarding which there was a letter in the present week's issue of that paper. It referred to Royston, in Hertfordshire, where it appeared that, two or three years ago, the medical officer of health reported a certain water supply as being dangerous to health. He believed there had been an outbreak of typhoid fever confined to persons using this water supply, and it was a perfectly clear case. It was brought before the sanitary authority with the common result that they did nothing. It was then reported to the Local Government Board, and they did nothing there beyond writing a letter periodically to the sanitary authority to say that such and such a thing had not been done, and asking why it had not. For two years that sort of thing had been going on, and to day there was a letter written by the vicar of the place saying that he had himself written a complaint to the Local Government Board, who contented themselves by referring it to the parochial sanitary committee, a body which had never met. That was the way in which the sanitary authority was worked now, and as far as he could see it was the way in which it would be worked to the end of the chapter as long as it depended on the Local Government Board to work it.

Dr. Bond (Gloucester) agreed with Dr. Child in the praise he had given to the hon. gentleman who had brought in the Bill now under discussion. It was an admirable Bill in two respects. In the first place, because, with all deference to Dr. Child, it provided as nearly complete machinery as you could expect, in the present state of public opinion, for enforcing proper water supply in the rural districts; and in the second place because it was so admirable an illustration of how the numerous difficulties in the Public Health Act might be dealt with, and this would have been hopeless if undertaken by the Government in a large comprehensive measure. He did not anticipate the difficulties which Dr. Child had raised, though he was not prepared to say that the Bill was a panacea for all the difficulties of water supply in rural districts; but he did believe it would enable a vast deal

to be done. There were, however, two defects in the Bill, which struck him as rather serious. In the first place, it provided that where the owner of the house, after being called upon to do certain works, did not do them, the sanitary authority should have power to do them, thus acting on the precedent of the Public Health Act. Now, to take a case which is sure to occur. Suppose the case of a rural authority, with some hundreds of houses to which the powers of the Act required to be applied, and suppose a small group of 12 houses without water supply, which had to be provided within the limits laid down by the Bill. Here he might express, in parenthesis, his surprise at the readiness with which this Bill had passed the House of Commons, for when the Public Health Act of 1875 was under consideration, in an interview which Mr. Ernest Hart and himself had with Mr. Sclater-Booth, when they strongly pressed upon him the adoption of some clauses which this Bill carried out, the honourable gentleman remarked that if that clause were passed it would practically confiscate a large portion of the cottage property in the country. To resume, when the matter was brought under the attention of the rural sanitary authority, the first question they would ask would be, "What are we to do?" They were told they were to take such steps as they thought necessary to enforce the supply, and they might carry out the works and recover the cost either in the shape of an improved rate or in a summary manner. To take the case of 12 or 15 houses on which it would be necessary to expend £100, where was the money to come from? In the first place it could only be obtained by a summary procedure, and the authority, after having done the work, might cite the owners before a Court of First Instance and recover it; but anybody who had had much experience in rural districts would know that the large majority of houses to be dealt with under this Bill belonged to owners who were too poor to find the money at all, or that the property was so divided amongst different owners that it would be practically impossible to get at them; therefore, if the work was to be done at all, it would have to be done by the sanitary authority, who could only recover it by the expedient of a private improvement rate. That meant that the sanitary authority would have to find the capital, and that its power of recouping itself would be limited to a private improvement rate, extending over three or four years. Now, taking the case of a large rural district, in which some hundreds of pounds would have to be expended in this way, in a year or two, if the Bill were really to be enforced with anything like energy, the sanitary authority would have to contemplate the raising of special rates to find the capital. It was true they would be ultimately repaid, but they were much more ready to recogniso the difficulty of raising a rate, than to appreciate the benefits that that rate when raised would confer on their poorer neighbours; and he entertained some doubts as to the enthusiasm with which rural sanitary authorities would put the Act into force. It seemed to him the remedy was an exceedingly simple one, and would be only a just consequence of the present law. If an urban authority wanted to provide a water supply, it could borrow the money direct from the Public Loan Commissioners; but if a rural authority required to spend some £400 or £500 for a number of what might be called small schemes, according to the powers of the Bill as amended by the Committee, there seemed to be no alternative but that they should raise the money by a rate. Now, why should not rural sanitary authorities be empowered to make annual application to the Public Loan Commissioners for such sums as they might require to carry out the provisions of the Act? Why should not a sanitary authority be entitled to form a little budget of its own, and make application for the amount required, the security being the rates of the district in which the schemes were to be carried out? It seemed to him that would not only meet the difficulty, but would redress a tangible injustice, namely, that where the owner of a house in a large village or town was required to provide a water supply for his premises, the law enabled him to do so by making use of the powers of the sanitary authority, to borrow money from the community at large. Why should not the owner of one or two houses in rural districts be entitled to do the same thing? The second practical difficulty was this. In the case to which he referred, of a dozen houses which were to be provided with a water supply by means of a well or laying on water from a neighbouring brook, in whom was the property to be vested? The well had to be dug, say, at the expense of 10 or 15 people, or the pipes to be laid for a certain distance at the expense of £40 or £50, but in whom was the property in that work to be vested? At present it would be vested in common in the owners of the property.

Mr. Brown said the well put upon anybody's property by a sanitary authority exercising the powers in this Bill would vest in the owners of the property.

Dr. Bond said you thus vested a property which really was a public charity, and for the benefit of a number of persons in common, in a single individual. It seemed to him it was carried out for the benefit of a number of houses together, and should be vested in the sanitary authority, and if you did that and gave that authority power to make a rate for the maintenance of the works, you made every provision which was requisite for their continuity, whereas if they were to be vested in a private individual, who might not always be found, and there was no provision for charge of maintenance, practical difficulties would ensue which might in some cases be of a serious character.

Mr. De Rance said the decision of the House of Lords referred to previously was given in the case of a township to which he had alluded in the 4th paragraph of his paper. The powers were refused, and that population had still only a small and polluted water supply, and the unfortunate people were suffering from typhoid fever. They wanted to go in for a private Bill, but were recommended to go by a provisional order. The order was granted, and they went to Parliament. A strong opposition came against them from various parties, and they were thrown out in the House of Lords on that technical objection, that although the Local Government Act of 1875 gave powers to take lands compulsorily and to erect reservoirs, it gave no power whatever to put water into them when they were made.

Dr. Syson thought, with Dr. Bond, that they ought to accept this Bill with thankfulness, and work it. No doubt in another year they would find out its weak points, several of which he could see, but still he thought it was workable; and after working it for a time they could correct them. One deficiency was that it did not say a word as to the standard of purity, or who should be the judges of that standard. He held in his hand some most remarkable evidence by Mr. Rawlinson, the engineer of the Local Government Board, which, he thought, showed the necessity of some definition as to the standard of purity, and of a court of appeal upon such questions. The evidence he referred to was at page 56 of the Blue-book, where Mr. Rawlinson said that he had ceased to care very much as to what chemists told him, because if only one-tenth of what was stated about water had been true, his only surprise was that a human being was left on the face of the earth. He went on to say that it was in his opinion the change of water which produced the mischief—that if you lived in a hard-water district, and were accustomed to that water, and then went some distance and drank water of a different character, it made you unwell, not because of its poisonous nature, but because it was not for the time suited to the constitution; so that they had the chief engineer of the Board saying one thing, and the chemist saying another, and he feared there would be no end of disputes as to whether a particular water was

good or not. If, therefore, Mr. Brown could see his way to introduce some court of appeal to which the water would be sent for analysis, he thought it would be well. To a certain extent, he agreed with Dr. Child's remarks that they ought to be careful as to throwing any more power into the hands of the Local Government Board. He did not speak personally, but he must say that that official department was so mismanaged, that it had become a laughing stock to the whole of the country. It had a most evil reputation amongst all the local bodies. He, therefore, thought they should encourage local authorities rather than this overwhelming centralisation which, he feared, the Bill rather tended to do. They ought to elevate Boards of Guardians and sanitary authorities, by entrusting them with more power. His experience was rather different to Dr. Child's. He believed local sanitary authorities in the country had done their duty very fairly, and to a certain extent, bravely, but the great obstacle was the Local Government Board, which would not allow them to work without such an amount of red tape that they dare not attempt it. The case of Royston had been alluded to, but it was only an *ex-parte* statement; and it must be remembered that, when you made a bargain for a certain number of years, and the time expired, either party was at liberty to reconsider it. It was a great mistake to abuse local boards and sanitary authorities too much. You should hear both sides of the question, and they ought to take those matters with a grain of salt, and to suspend their judgment until they heard what Royston had to say. He lived a little nearer to Royston than Dr. Child, and probably it would be persuaded to rejoin the combination. There was a curious example of the action of the Local Government Board. An inspector came down, and tried, on the one hand, to bully them, and on the other to cajole them, into joining the combination, saying, "If you do not, I do not think I shall recommend the Local Government Board to pay half the salary." He might also mention that Royston paid £200 a year for services for which the Union next to it only paid £80 or £100 for, and this did not seem to be fair or just. If they would cleanse the Augean stable at Whitehall they would soon see a vast improvement.

Dr. Child asked leave to say a word in explanation. He had not said anything against the Local Government Board at all that he was aware of; on the other hand, he thought that considering how great a preponderance of motives they had to do with, it was rather surprising they had done so much. What he did object to was, that the Board, which was simply to act as a main spring, had not acted at all. With regard to the Royston business, he did not attempt to enter into the merits of the local squabble about which he knew nothing, but he merely quoted it as a case in which the water was condemned by the medical officer of health, and when the matter was brought before the Local Government Board it entirely declined or neglected to act.

Mr. Homersham, referring to the clause in Mr. Brown's Bill, which gave power to supply water from a stand-pipe at the end of the garden, or at a distance, instead of going into the house, speaking from large experience, said that was a most abominable way of supplying water. It would not cost more than £1 to bring it inside the house, and there were so many practical objections to a stand-pipe that it was a bad system to sanction. In frosty weather it would be frozen and burst; it was a great hardship on old people to have to go out to fetch water, and they would have to keep it standing in a pail in the house, where it would get contaminated. He considered it a step backwards instead of forwards to be allowed to supply water in this way.

Mr. Evans said he was not aware of the Bill brought in by Mr. Brown when he spoke in the morning, and congratulated that gentleman on his achievement. He fancied if it had been a Government Bill it would not have been so effective, and he would only express a hope that too much attention might not be called to it, or there would yet be difficulties in carrying it into operation.

Mr. Brown said he agreed generally with Dr. Child as to the character of permissive legislation, but, unfortunately, the Public Health Act was of that character. Three or four years ago he moved in committee an amendment to strike out the word "may" and insert the word "shall" wherever it occurred, but he found that that would be too sweeping a change, which would not work, and from that time to this he had been trying to see what could be done. Dr. Child feared this Bill would be only another addition to the permissive character which legislation still assumed, but there was a very important difference in his Bill, namely, that you threw the incidence of the charge on other people. In the Public Health Bill, wherever water supply had to be introduced it was the ratepayers of the district who had to be burdened; but, under his Bill, the burden would be thrown on the owners of the property, and therefore it would be found that sanitary authorities when they had not got to pay for it themselves, but to throw the charge on other people, would be much more likely to put it in operation. Again, with regard to the 299th Section of the Act of 1875, which gave power to the Local Government Board to come in and act on default. There was a clause in his Bill which provides that if any memorial were sent up from an owner on the ground that he ought not to be compelled to provide the water supply, that was to be considered as a complaint of default made to the Local Government Board. So that practically he cut out the first stage of getting up a memorial against the authority, and a Local Government Board inspector would at once go down and see what should be done. He could assure Dr. Bond that no one was more surprised than he was how the Bill got through the House of Commons. The fact was it was sent to a Select Committee on which both sides took part; those who were opponents, having heard the evidence, became supporters, and in that way it got through, and not a single word ever appeared in the House of Commons as being said on the subject. He only hoped it would be treated in the same way in the House of Lords. With regard to borrowing money, he was informed that a local authority, urban or rural, could borrow even very small sums from the Public Loan Commissioners.

Dr. Bond—Only where the property is vested in the sanitary authority.

Mr. Brown said if they made the water supply themselves then they could borrow the money. With regard to the question of the property vesting upon the estate of one person where a common supply was to be made for two or three persons, he had met with considerable difficulty in drawing the Bill to meet such cases. But supposing a well or a tank were to be put down, in that case, if the sanitary authority had no land of their own, it must be put on the land of some other person. If it was put on the land of A, it was quite plain that B, C, and D, cottage owners round it, should not be charged with the cost of that tank unless some agreement were entered into by A, that the occupiers of B, C, and D should always have a right of user of the water, and the reason why he thought that A would consent to give such right of user was, that in that case he would only have to pay one-fourth of the cost. If A's cottage were in want of water, it would be in the power of the sanitary authority to supply the cottage, and in that case he would have to pay the whole of it; but where a common supply was provided it could be done much cheaper. It would be to A's interest to allow the tank to be put on his land, and to pay one-fourth the cost, giving a right of user to his neighbours. If that did not work, there was another plan. Under the existing law, the sanitary authority might enforce the 176th Section of the Act of 1875, which gave them power compulsorily

to purchase land on which they could put the supply, and in that case they could borrow the money, as suggested by Dr. Bond. Rural authorities had the same power as urban with regard to borrowing and purchase of land. In case of supplying a place with pipes laid on from a spring, the same difficulty did not arise, because there they had full power under the present Act to lay mains wherever they chose. Where engineers, chemists, and local government officers fonnd it so difficult to define what was pure water, he thought it was very hard for a private member of Parliament to be called upon to do so, and therefore he must decline the task.

Dr. Syson said he only asked for some analytical court to which cases should be sent.

Mr. Brown said some years ago, when investigating the great question of the adulteration of food and drugs, they found a great difficulty in providing a court of appeal, which, after all, was not very satisfactory. This Bill was only an attempt to do something towards a great subject, and if it passed through the House of Lords he hoped it would work satisfactorily.

The Chairman asked Mr. Brown whether his Bill applied to future buildings, or only to those which at present existed, because he could imagine that although the right of property might intervene in one case, it would not be so very terrible a thing to say that a house should not be built unless it were supplied with water.

Mr. Brown replied that his Bill provided for that, and read the clause bearing upon the report.

The Chairman said that clause was quite satisfactory, and he hoped the Bill would pass. A question had been asked about the standard, and the Local Government Board seemed to be rather in a difficulty on that point. But he might mention what happened in his own experience, which he thought suggested a mode of arriving at a reasonable, common-sense standard. Two years ago he went to Birmingham, and took a furnished house, but after being there a short time he thought the water was not very good; and it being notorious that in Birmingham the wells were generally very near to the cesspools, he had his suspicions about it. He wrote to the sanitary authority, to request that he would come and look at the water. He came with an official bottle, and carried off a specimen, and in about a week returned it, saying he would advise him never to drink it again, as it was very badly polluted; and if he was obliged to use it, by all means boil it first, and then filter it. Fearing it would be a case of incipient typhoid fever, he immediately wrote to the corporation, which supplied water when requested, and asked to be supplied with the corporation water. He heard no more of it until, in the course of a week, a couple of plumbers came in, cut up the ground, and laid on the corporation water. After that there came another set, who cut down the pump; and three or four days after, another set came, who filled up the well. He then met the agent of the house, and asked him if he knew what was going on, and he replied, "Oh, yes; we have just received the bill." This showed the way in which things were managed in Birmingham, the most undespotic place in the world in its political views. He had only to complain about the badness of the water, it was referred to the official authority, and the supply of polluted water was cut off. Would it not be advisable, without troubling the central office in London, to refer all questions of this kind to the public analyst of some large place, like Birmingham, who would be unbiassed, paying a proper fee for the analysis.

Mr. Brown said that, by the frame of the Bill, the medical officer of health was the person to say whether the water was wholesome or not.

Dr. Syson said it was also to be judged by the inspector of nuisances, which he objected to.

Mr. Brown said, when he first drew the Bill, he left it entirely to the medical officer of health; but the committee thought it right that, in certain cases, as to the means of making the supply, the distance of the supply, and other points of that kind, it would be well to join with him the inspector of nuisances, and that was put in as a compromise between two sets of opinions. As many people were aware, there was a fierce fight going on in some parts of the country with regard to the position of medical officers of health, and this was a matter on which he was obliged to make a compromise, which had been accepted by the committee, and which he hoped would be allowed to stand. When it became a question of scientific evidence as to the wholesomeness of the water, that ought to go before some scientific man, not to be decided by the medical officer of health.

Dr. Syson said that, except in rare instances, inspectors of nuisances had no sanitary knowledge whatever, and there might be a difference of opinion between them and the medical officers of health, as was the case now at Royston. He would suggest that the county analyst should be named instead.

Mr. Brown said he had thought of the county analyst, but, by the Adulteration of Food Act, he found the county analyst was absolutely forbidden to analyse water.

Dr. Bond suggested that both the medical officer of health, and the inspector of nuisances should be cut out of the clause, and simply leave it "when it was reported to the sanitary authority that the water was unwholesome."

The papers contributed by Mr. Jackson and Mr. G. F. Wills having been read,

Mr. Underwood said the meeting seemed to have been discussing entirely the matter of potable water; but there were other things which water was required for besides drinking. They ought to consider the fish in the rivers, and the land, which required water as well. Some years ago, he wrote a letter to the *Builder*, in which he called attention to this matter; pointing out that the want of water was in a great measure caused by our not storing up the rainfall, as was formerly the case. The land was now so perfectly drained for the purpose of agriculture, that the water ran directly to the rivers, and nothing was provided to make up for the loss. He proceeded to read from the letter referred to, the principal point of which was, that along the course of all the rivers large tanks or artificial mains should be provided of equal capacity with the river itself, so as to afford larger storage room; and in the second place he contended that the present system of water-closets was answerable for a great deal of the evil complained of. Even the contact of water, impregnated with foul gases, with the lead soil-pipes was very prejudicial, and he had calculated that about 600,000 lbs. of lead was thus carried into the sewage of London. Now, according to Mr. Wanklyn, one-tenth of a grain of lead would poison one gallon of water, so that the quantity above-named would poison a lake of $21\frac{1}{2}$ square miles and of a depth of 10 ft. All this lead was thrown into the estuary of the Thames, and when that was the case they could not expect that fish would come up the Thames or oysters breed. If they could do away with water-closets and save the rainfall by a system of reservoirs, the rivers would be kept to a proper height, and the national question of a water supply would be reduced to the smallest limits.

Mr. Joseph Whitley said he came to this subject with one idea. The whole source of the water supply was the heavens, and the mode of appliance was engineering skill. He held, with Mr. Pierce, that we should take the supplies at the first point, preserve them, and then distribute them over the length and breadth of the land. It was a scientific question, but there were many men who could build tanks for the sewage of a city like London, and could build over them if necessary, and certainly they could collect the pure waters of heaven

and distribute them over the land. Where it was necessary to raise the water, the motive force of the wind might be utilised, and the motive power which momentum and specific gravity gave it, before it was distributed for domestic purposes, might be called in aid of the same purpose. The thing was perfectly simple, and he was only astonished that that meeting had only taken so little notice of the natural facts.

The Chairman having called attention to an article in the *Royal Agricultural Society's Journal*, by Mr. Wheeler, C.E., which went over a great deal of the ground which had been discussed that day, adjourned the Congress till the following morning.

The Congress was resumed on Wednesday morning at 11 o'clock, Sir HENRY COLE again occupying the chair.

The Chairman said the subject for that day's discussion was the supply of London, and suggested that the financial part of the question should be left on one side. He apprehended what we wanted in London was an unlimited supply of the purest water. The existing methods might be discussed, but as to ing into the question how it was to be got commercially, it seemed to him they would not arrive at any satisfactory conclusion, and it would be a pity to take up the time of scientific gentlemen in discussing whether or not private companies were entitled to 50 per cent. dividend. He would ask Dr. Frankland to commence the discussion, and the question he would put to him was, whether we could have as good water as Manchester, and in unlimited quantity.

Dr. Frankland said that London, from its geographical and geological position, ought to be supplied with better water than any other large town in the kingdom. Working for six years on the Rivers' Commission, he became acquainted with most of the principal river basins both in England and Scotland, and the impression made on him and his brother Commissioners was, that amongst those river basins there was not one which yielded such an abundance of good and wholesome water as the Thames basin. There were two chief kinds of good and wholesome water, namely, upland surface water and subterranean water. Of upland surface water, in a good condition, there was very little in the Thames basin, but of subterranean water there was a good supply, which was quite sufficient for a long time to come. He knew this was a disputed point, and he would give every weight to the arguments of those gentlemen who had gone into the subject from a geological point of view, and taken gaugings as to the quantity of water which would percolate through and into the chalk, or the proportion which evaporated from the surface, but eventually they must all yield to the broad fact that, in a long continued drought, the Thames was supplied exclusively from springs, and those springs emerged almost exclusively from the chalk and oolite. Now, in the driest weather since the gaugings of the Thames were taken at Teddington Lock, at least 350 million gallons of this water passed over the lock, and that was after the abstraction of some 50 millions by the London water companies. That was practically the minimum yield of subterranean water in the Thames basin above Teddington Lock, but there was a great deal obviously came into the river and estuary below Teddington which could not be so estimated, first of all from the want of gaugings, on the Lee, Medway, and other streams, and, secondly, from the impossibility of ascertaining how much of this good water made its way into the bed of the Thames itself, and even out to sea. Looking at it from this point of view, there could not be a doubt that very large volumes of this wholesome spring or deep well water might be obtained for London. Unfortunately, at present this water was delivered to consumers after it had served the most filthy purposes, the washing of dirty rags in paper mills, and the flushing of the sewers of a very large population. The problem before us was to obtain this water for the people of London before it had been put to these abominable uses. Surely it could not be beyond the powers of Parliament and engineers to collect and preserve from dangerous pollution a small fraction of this prodigal supply, and to distribute it to those portions of London which, at present, drink it after it has been mixed with the excrements of more than half a million of people. The next point to consider was the desirability, notwithstanding this abundant supply, of economising wholesome water, as distinguished from water used for other purposes. After being opposed to the idea for many years, he had at last come to the conclusion that it would be very desirable to have two systems of water supply in London It did seem to him to be a waste that there should be such an immense quantity of water supplied to London to be used as mere driblets issuing into private drains, and thus making their way into the sewers; it seemed a pity that the unpolluted water of the Thames basin should be used for this purpose, and, moreover, it would cost a considerable sum to displace the whole of the present supply by water of a perfectly satisfactory quality. But in making this division of the water into wholesome water fit for dietetic uses, and water sufficiently good for manufacturing and trading purposes, flushing sewers, and watering the streets, he did not favour the notion of introducing two kinds of water into houses. That he thought would be very dangerous. In perfectly well regulated houses it might be possible to keep the wholesome water for dietetic use, and the other for closets, baths, &c., but in ordinary households this would be exceedingly difficult, because the servants would go to the nearest tap, whatever the quality of the water might be. He would divide the water supply into two sections, namely, the in-door supply and the out-door, introducing the former only into houses. It would, of course, be said at once that the in-door water supply was at the present moment enormously greater than the out-door, and this could not be disputed. The domestic supply in London amounted to about 97 million gallons daily, whilst that used for trade and other purposes was only about 22 millions. But was all this quantity of in-door water necessary? He thought not. He believed there was an enormous waste of water in houses, which really did no good in any way. It was sometimes contended that this leakage from the cisterns and taps helped to scour out the sewers and keep the drains clean; but every engineer would agree with him that water applied in that dribbling fashion was of no use for such purposes, and that a very small fraction of the volume applied in a proper way for flushing would be of much greater benefit. He would, therefore, have the sewers flushed from without, and this flushing should be under the control of the sanitary authority, whilst the water supply within the building would, of course, be under the control of the householder exclusively. But how were they to prevent the waste of this excellent water supplied to the houses? Simply by using meters. He believed that would at once put the domestic water supply throughout the country, especially in large towns, on a satisfactory footing. The only objection he had heard against this system was the impossibility of getting good dividends from it. That, no doubt, was a very forcible objection, and one which should be taken into account. But let the water be charged at a sufficiently high price by meter, and the difficulty would be removed; they need not sell it according to the terms at which it was now supplied to manufacturers, and in the case of very small houses it would be necessary to supply rows or several houses grouped together from one and the same meter, in order that the expense of meter rent might not be too great.

It seemed to him that the supply of something like 30 gallons per head of population in London, and 40 gallons per head in Glasgow, was perfectly outrageous. If you compared the domestic with the manufacturing supply in large towns, it would be found that the domestic supply was always enormously in excess, and this arose mainly from the unrestricted use of water in houses, and the restricted use in manufactories. The latter had to pay by volume, whilst the householder paid upon his rental. In Salford the household supply was 1,100,000 gallons, whilst that for manufacturing purposes was only 400,000; and in Manchester, of the whole supply, two-thirds went for domestic purposes and only one-third to trade purposes. In Glasgow the domestic supply was 20 millions of gallons daily, and for other purposes only 6 millions, the latter being supplied almost entirely by meter. If this plan were adopted, householders would take care that there was no leakage, and, for all practical purposes, they would have as much as they could use to any good purpose. 10 gallons per head per day would be amply sufficient. The experiment had been tried for many years in Malvern, and he was told some years ago by the engineer that all water was supplied there on the constant system by meter, and the consumption was 7½ gallons per head per day. He said it was financially not so good a method as charging on the rental, but it was found to be a sufficient supply in that sanatorium, where, presumably, the demand for water would be above the average. By thus separating the in-door from the out-door supply, selling the in-door supply by meter, and employing the out-door in abundance for flushing sewers and other sanitary purposes, they would greatly diminish the difficulty of supplying large towns with pure and wholesome water. By making this separation it would be unnecessary to purify such water as was used for out-door purposes, thus the Thames water at London-bridge would be pure enough, especially if it were allowed a day or two to subside.

The Chairman asked if it would be pure enough at Crossness?

Dr. Frankland said certainly not. He was able to make this statement on account of the diversion of the London sewage, and of its being discharged at Crosness and Barking, as it was now. He did not make it on speculation, because he had repeatedly analysed the water at London-bridge, and it was remarkable how little extraneous matter there was in it after subsidence beyond what there was in the water at Teddington Lock. It did not contain much more organic matter in solution, and would be quite pure enough for out-door purposes.

Mr. Chadwick asked how much impurity the water at Teddington Lock contained after the sewage of 40 towns had been let into it?

Dr. Frankland said it sometimes contained as much as ·520 part of organic elements in 100,000, whilst at London-bridge it only averaged, at all times of tide and after subsidence, ·505 part of organic elements in 100,000 parts of water.

Mr. Conder asked at what time of the tide, both lunar and daily, these samples were taken?

Dr. Frankland said he had taken them at all times of the day, both at high water and low water, but he would not say that in a strong spring tide you might not get some of the London sewage from Barking and Crossness. He had gone very carefully through the report of the investigation made by Messrs. Bazalgette, Bramwell, and Easton, on the necessity for a high pressure for the extinction of fires, and he thought there could be no doubt, from the result of their experiments, that it was absolutely necessary for the safety of London to have a separate and special supply of water for that purpose. The present mains could not possibly bear the necessary pressure for effective work against fire, but he should venture to differ from the engineers of the Metropolitan Board of Works in this respect, that he would use the new system of mains, which it was proposed to lay down, for the supply of *out-door* water; and would use the existing system for *in-door* water, so that the impure water would be used for the extinction of fires, for which purpose it would be just as good, and the present mains and fittings in London would remain as they were at present, unless the consumer liked to alter them; each tenant, however, should be required to consume the water through a meter. He believed that in this way, not only in London, but in many other large towns who were crying out for water at the present time, good, wholesome, and pure water, in ample quantity, could be provided for domestic use, and a larger quantity than was at present available be set free for manufacturing purposes. He might add one word with regard to hard and soft water, which it was perhaps important to bear in mind in connection with domestic supply. Amongst the results of recent investigations into the wholesomeness of water, it had been ascertained that hard and soft water was equally wholesome for dietetic purposes, within certain limits; the hard chalk water, at all events, and the softest water you could get from upland sources, were equally suitable for domestic supply. If you contrasted towns supplied by these two descriptions of water, and which were similar in other respects in sanitary conditions, you would find that their death-rates approximated very closely.

Admiral Sir Erasmus Ommanney, C B., F.R.S., was very glad to hear Dr. Frankland speak so strongly in favour of the Thames, and wished to ask whether he could give any information as to whether the water was purer now than it was in 1866, when the upper part of the river was transferred to the Thames Conservancy? The river was then in a bad state, the locks being decayed, and the water running to waste. Since then they had done a great deal, and now every town that stood on the river, excepting Oxford, Windsor, and Kingston, had diverted their sewage from it, and he should like to know if the effects were perceptible.

Dr. Frankland said, unfortunately, he could not give a very definite answer to this important question, because there were no analyses regularly made of unfiltered Thames water arriving at Hampton, where the companies took it in and filtered it. His analyses had been chiefly confined to Thames water as supplied to London, but, as regarded this, he was bound to say there was very little improvement since 1868, and a considerable deterioration since 1870. He did not know how that was to be interpreted with regard to the purity of the Thames itself, because so much depended on the mode in which the companies manipulated the water after they received it. It might be that the Thames was better, and the companies were more careless, but he must say that the results of his monthly examinations lent no countenance to that view, because, whereas at the first period mentioned, the filtration by the companies was very defective, and the water delivered in London was very frequently turbid, at the present time it was usually well filtered, and delivered in a clear condition. As far as he could judge from the data before him, there had been no improvement in the quality of the Thames water during that time.

Sir Erasmus Ommanney wished to add that the actual amount of in-take by the companies was 62 million gallons.

Mr. De Rance said the Acts of Parliament gave the companies power to take in 110 millions of gallons a-day from the river, and he should like to ask Dr. Frankland if he considered that, if that extra 60 millions were taken and softened by Clark's process and otherwise purified, it would be of a sufficiently good quality to answer for the pure water he proposed. As

regards hydrants, he should like to ask whether reservoirs, being only at an elevation of 400 ft., would give sufficient pressure to work the hydrants in the higher portions of London.

Dr. Frankland said he did not think the Thames water, as taken at Hampton, even if softened and filtered in the best possible way, could be made sufficiently pure. What he had referred to was the water issuing from springs or obtained from deep wells, and conveyed to the consumer without previous admixture with sewage and other impurities. That would have to be done with the excellent water which was met with everywhere in the Thames basin, if they were to have it wholesome and fit for dietetic purposes. The second question was rather one for an engineer, and he could not pretend to answer it.

Sir E. Ommanney said that Oxford was at present laying out £150,000 in works for diverting their sewage from the river, which he hoped would be in operation in a few months.

The Chairman said a question had been handed up to him to put to Dr. Frankland, as to what distinction he drew between "good, wholesome, and pure," as applied to water?

Dr. Frankland said he had used the words as practically synonymous.

Mr. Williams (Liverpool) thought it would be very dangerous to attempt any such operations as that suggested for limiting the supply of water to London houses. On the contrary, in his experience, the need of the whole country was a much larger supply. Some years ago he saw a model in glass showing a sewer, the pipe leading from the sewer to the respective traps, and syphons right up to the closet pan. Then the glass was filled with water; and, thirdly, a portion of sewer gas, of the strength found in the Liverpool sewers, was let into the glass pipe near the sewer. It was marvellous to observe with what rapidity it worked its way up through the trap, and through the water again to the syphons and sinks, and to the water-closet. Before the sewer gas was let in, of course there was no smell, but in a marvellous short time it became so offensive that the observers had to run away from it. There seemed to be an idea in the country that, if you only had traps and syphons properly filled with water, you were perfectly safe. During the day, when the bath, the water-closets, and the sinks were in use, you were comparatively safe, by reason of the water being constantly changed in the traps and syphons; but during the night it was far different; it was extraordinary how very soon the water in the trap became penetrated with sewer gas, and thus in effect the sewers were not trapped at all. He would venture to suggest that those driblets, which the Professor made so light of, were of the greatest importance. He knew the engineers throughout the kingdom were endeavouring to deliver the least possible quantity of water, and they had inspectors calling at the houses, trying whether the taps were tight, and if they were not, notices were immediately served; but he considered that it was in the interest of the public health that the taps should be out of repair, and that dripping should go on, particularly during the night, because the more water that went through the taps, the more would the gas be diluted and their health protected. These being his strong convictions, he should regret if the time ever arrived, in London particularly, for such a change as had been recommended, because he feared, if carried out, there would soon be a change in the death-rate. Remarks had been made on the previous day as to the changes which had taken place in Liverpool in taking the water service out of the houses and putting up stand pipes, which he considered very prejudicial, and he hoped the Legislature would soon compel a service to be placed in every house.

Mr. Joseph Lucas said the Thames basin contained a great variety of geological strata, the principal water-bearing strata being the chalk, and the chalk hills enclosing the basin. If these hills were transparent, it would be seen that they contained a mass of water which rose like a wall in certain places, the elevations approaching 500 feet, to his own knowledge, and he believed Mr. Homersham had mentioned a case where it was still higher, but the quantity of water represented by those sources could not be very large, simply because they underlay the highest part of the chalk hills, which from the fact of being on high ground were in a great measure devoid of fissures in which the available free water lay. As had been pointed out by Mr. Latham, where the gradient of the water surface was the steepest, the quantity to be got from wells was the least, and that was a very important consideration. The volume of chalk occupied in that way by water is principally capable of being increased by artificial means. Above the water line there was an enormous volume of chalk unoccupied by water, but which could be made to hold it. He did not wish to go into the means, but merely to point out that there was this volume of dry chalk. The first thing which suggested itself was, how far it was possible to augment the supplies of water which already existed in the chalk, and the second, was there an extending area, particularly in the neighbourhood of London? There would be a great depression of the water line over a long series of years. And that would suggest a second principle, namely, how far it would be possible to replenish the exhausted parts of these water-bearing strata by re-charging them with water from floods. There, again, he did not wish to address the meeting from a constructive or engineering point of view, but simply to point out a very remarkable instance of natural replenishment, which went on year by year. It might be seen on his map that towards the top there was elliptical sweep that surrounded the isolated catchment basins of the Mims; that was a catchment basin of about 23 square miles in extent; the whole drainage of that area fell into the chalk at some well known swallow-holes, and the quantity of water thus carried in must be very large, it still maintained the area of over-flow into the valley of the Lea at Edmonton. Now, since the catchment basin consisted of highly cultivated land, both agricultural and pasture, it followed that in that way there must be something carried in from the manures put upon the land, but yet it was of a most excellent quality in every way. A great deal had been said about the impurity of flood waters in connection with their utilisation for water supply. But, as a matter of fact, they were used now, and the water taken out of the chalk was all water which had been, in some shape or other, diluted, to say the least of it, with manure, but he had not the shadow of a doubt that it was excellent water, and he should not be afraid to drink it anywhere. That also led to the subject of the purity of the water in the chalk, which had been pointed out by Professor Frankland. As matter of fact, the chalk everywhere was subject to an enormous amount of contamination from farms, cesspools, and manured lands, and Mr. Homersham had told them that three generations of well-sinkers had made their living by sinking dry wells, for the purpose of draining farms into the chalk, and yet, notwithstanding all that pollution, they got excellent water out of it. The Thames basins contained a number of areas on which the water from the chalk naturally rose above the surface, whence it was liberated by borings, and that led to a principle which ought not to be overlooked. Those borings brought to the surface a very large amount of pure water, and if it were desired to bring an equal quantity of equally pure water on to the same areas from any outside source, it would be found that the cost to raise it by means of borings would be quite inconsiderable when, compared to the

cost of any scheme for bringing it from a distance. Therefore, wherever these natural areas of overflow existed they ought to be protected, and if wells ever should be sunk into the chalk on a more extensive scale than at present for the supply of London, they should be made on such a principle as to preserve those areas of overflow. Up to comparatively recent times, in the valley of the River Colne, there had been about 140 square miles of country which could very well have been served by means of overflow wells; but, owing to the depression caused by the London borings, those areas had been reduced to about 34 square miles. They still enjoyed the very high privilege of this pure water, raised by means of overflowing artesian wells, and, in some instances, that water rose to 25 ft. above the ground, and therefore could be used to supply houses at the top. In addition to those areas known to exist, there were certain others in the Valley of the Mole, Wey, and north of the Hog's-back, which were still improved, but his own examination of that very large district led him to conclude that if borings were put down the water would overflow. It so happened that, in one of the districts, north of the Hog's Back, the people were now much distressed for want of water, particularly in the village of Flexborough, and he felt confident that if a boring were put down into the chalk there the water would rise 50 ft. above the ground; at least that was the theoretical height, but if it got to 40 ft. that would be quite high enough; and there were other areas in the Thames basins, as, for instance, in the valley of Sodden, a little further west, which should not be lost sight of. There could be no doubt that in the Thames basins there was ample water for the supply of London; but if it were taken by means of chalk wells, and in such a way as to depress the water line, it would be obtained at the expense of the localities from which those supplies were taken.

The Chairman asked if that map was not based to a great extent on the geological survey.

Mr. Lucas said his lines were drawn on the geological survey map.

Mr. Conder asked if Mr. Lucas could state the quantity of water which fell over the large area of permeable beds to the south of the Hog's Back, and what became of it.

Mr. Lucas said he had not actually measured the line of the lower greensand south of the Hog's Back, but he had a great portion of the area east of the valley of the Wey; and with regard to what became of the water, he had formed an opinion that it did go out by the Wey. He questioned very much whether much went under the gault, because when the lower greensand was met with in deep borings, it was found to be very much more solid than it was on exposed hills.

Mr. Conder said that Guildford was supplied by a well which was sunk 30 feet into these sands, and it had, perhaps, the best supply of water in the country.

Mr. Edwin Chadwick C.B., said—This subject of the supply of water to the metropolis was, I think, last settled, or conclusively re-affirmed as to the principle, by the report of the Select Committee of this Society three years ago. What is immediately to be added to the discussion, are answers to continued misrepresentations, some of which I have given in a distinct paper, which there has not been time to read. It may, indeed, be shown that the principles were settled in 1850, in the report of the first General Board of Health. On the examination under that Board, the state of disputation was found to be like that of the antagonists who were fighting on the view of different sides of the same shield—and such is the state of the controversy maintained at the present time. On the side of the water companies, the question is as to the wholesomeness of the water, as it is delivered by them in their mains at the doors of the houses of the consumers. And, on the whole, it is found that their ease is well founded, that their delivery is within the terms of their contract with the consumers, represented by the Government water examiner. On the other hand, the question maintained by officers of health, and others interested in sanitation, is as to the qualities of the waters as used. Of the water distributed, the water reported by Dr. Frankland to be of the highest degree of purity is that derived from deep chalk water springs, and delivered by the Kent Water Company; and as against sewage and other contaminations, there can be no doubt of its superior purity. But as respects this same superior water, as delivered at the door, there is certainly less doubt, from the reports of the medical officers of health, that, as used, after having been detained and kept in stagnant butts and cisterns in close courts and alleys, near dung heaps or cesspits, or in mugs in overcrowded rooms, it absorbs the sewer gases, and it is positively unwholesome and unfit to drink. Anyone who at times would go into a court or alley in Rotherhithe and drink the Kent water from the butts in which it has been kept stagnant, would suffer for so doing. The ordinary deterioration of the purest water delivered has, I am assured, proved such as to reduce it for use to the level of impurity of the least pure water delivered from sewer-tainted sources. Hence the beverage of the lower classes of the population is not water but beer. Then as to the pure water so tainted, and afterwards befouled by the uses to which it is put in the house, it was proved that full three-fifths of it was delivered in mischievous waste. It commonly permeated and supersaturated the subsoil through permeable brick drains and sewers in the lower districts. By this waste, sodden sites and subsoils are created. This evil is, of course, the greatest in the lower districts. Hence, on an examination, it appeared that the attacks of epidemics of typhus and cholera are proportioned very much to the height of the districts above the Trinity high water mark. The attacks were double in amount in the lower and supersaturated districts to what they were in the higher and the drier districts. Now, look at the state of information in which these conditions continue to be disregarded! The quantity of water now distributed in London averages 32 gallons, or some sixteen pailsful per head of the population; or in a household of five some eighty pailsful a day. What sort of a household must that be where half that would be used daily? A quarter of that would exceed the average needs for domestic consumption! At Liverpool, the quantity distributed was about the same that it is now in London;—but chiefly by an able system of meterage by Mr. Deacon, the borough engineer, it has been reduced to about one half what it is in London. The sanitary result of this reduction in Liverpool is confirmatory of our conclusions as to the waste of water being an important factor in the insanitary condition of the metropolis, and in other cities where the like waste is committed by insanitary engineering. It was found that at Liverpool the result was to keep the foundations of the houses damp, as an instance of which it is stated in the report of the Water Committee there that in one street water-cress was grown in the cellars for market. Their report states "that under the old system," *i.e.*, the one maintained in the metropolis,—"the water was collected in tubs and other receptacles, and thus imbibed the surrounding effluvia and gases and became vapid and raised in temperature, and, doubtless, was avoided for drinking as far as possible. The water is now on night and day, and even in summer is cool and refreshing." The committee further report a reduction of the death-rate, as attendant upon the reduction of the waste," and they state, "When we remember that a reduction of the death-rate of 1 per 1,000 represents 550 lives annually in the borough alone, and that these 550 lives after all bear a small proportion of those suffering from sickness, this question

is one of the most important that can occupy attention." They report as general results of the change which, *mutatis mutandis*, are applicable to the present condition of the metropolis in respect to its water supply. "In addition to the pecuniary results, we have converted a nine hours service into a constant service; we have saved water sufficient to meet the increasing wants of the town and neighbourhood for eight years longer than would otherwise have been the case; we have given additional facilities for the extinguishing of fires; we have relieved the cottage owners of the maintenance of 9,700 taps in the courts and alleys; and we have, with the assistance of the health committee, undoubtedly contributed to the reduction of the death-rate." The quantity distributed in the metropolis being more than double the quantity consumed—or 32 gallons per head of the population, we have had proposed at this Congress a plan for augmenting it to 50 gallons or 25 pailsfull daily at an expense of ten millions and a half. Other engineers have proposed yet grander plans for bringing in 200 gallons per head of the population, which would be for domestic consumption about four hundred pailsfull per house. Four hundred pailsfull! Think of the swamps created, or of the additional cost of pumping out all this mass of water pumped in on this grand plan. Such facts display how little there is of sanitary knowledge—of intelligence, or of *morale* in the municipal representation—or, indeed, in the superior representation in the metropolis—for the removal of the insanitary conditions in which the fever-stricken, phthisis-ravaged, rheumatism-ravaged, and heavily death-rated populalations of these lower districts are placed, or even for the prevention of further aggravations of those conditions. From one of the water companies, which has attained its maximum dividend, it is, indeed, put forward, as a ground for the maintenance of the existing conditions of distribution, that there are no complaints against it. Nor is there likely to be anything but resistance of change from these Vestries, composed, as they are, largely of owners of the poorest class of tenements, when, as I have shown in the paper I have given for the Congress—the expenses of making the required changes are enormously exaggerated, and these small owners in Vestries are led to believe that they must bear them all, and when the economies derivable from consolidation, on a public footing, from whence they may be relieved from them, and even have their properties improved by them—are suppressed. On behalf of water companies' shareholders, who begin to feel that their interests, from the very slowly increasing dividends and the distant attainment of the maximum dividend they were promised and guaranteed, are very distinct from the interests of the directorates, and from a very searching inquiry made by competent experts, it is most satisfactory to find that the economies derivable from unity on a public footing were, to an important extent, understated by us. For example, we estimated the reduction of the general intake of water by the reduction of the waste at one-third; but it is shown, from increasing examples, that a reduction to the extent of full one-half is practicable. This implies a proportionate reduction of administrative establishments, and a large reduction of works, and—as one item of economy—the reduction of the cost of pumping out some sixty millions of gallons daily of the surplus water pumped in, and of dispensing with the whole of the intake of water from the sewer-tainted Thames. The companies put forth the cost of their works at thirty millions. At a time when their capital was not above six millions, and their dividends five per cent.—having been promised ten—it would have paid the public well to have paid them off at their maximum dividend, and as against further impending augmentations it would be cheap to do so now were it necessary. But it is proved on the results of the shareholders' investigation to which I have referred, on the bases lately sanctioned by Parliament, which are of twenty-five years' purchase of the maximum in dividend earned, with an allowance for prospective advantages and compulsory purchase, the payment required would be much less than that, and including an allowance for compulsory purchase it would be about twenty-six millions and a quarter. It has been imagined and put forth that it would be necessary for the Chancellor of the Exchequer to raise all this money for payment. This is a wide spread financial blunder. We proved that it would not be necessary for him to raise a shilling. As a compromise, for the shareholders promised maximum dividend of 10 per cent., which with the sanctioned allowance for compulsory purchase, would be upwards of 11 per cent., to be gained some years hence, it is proposed, and accepted, by a large proportion of the shareholders as a compromise, that they should have public security for an augmented dividend to about nine and a half per cent. The solution is, therefore, a mere matter of account, in which no money is required to be raised. On the other hand, the proved large available ecomomies capitalised will more than cover this extra dividend, and will enable the house services to be improved without expense to the owners or to the occupiers; the streets to be all hydranted, and the mains to be enlarged for protection against fire; and leave an increasing surplus available, either for the reduction of artes, or for future improvements. This may appear to be too good, but it is demonstrated on close inquiries, by the most eminent accountants. In our view all questions as to new sources of supply, such as those of which we have heard at the Congress, are, as respects the metropolis, premature; the first thing to be done being to get the existing supplies and works on a public footing under unity of management, as recommended by Royal Commission after Royal Commission—and to abolish those conditions which make the best of the existing supplies bad, and the bad supplies worse. The blundering deviation of the Board of Works from this course has beset them with fatal multiplied oppositions to their Bills. On the part of the Government, it was announced that they must oppose these Bills, as I expect, on the insufficiency of any scheme for fire protection in which the supplies are not in the hands of the police, as well as respects the the inadequacy of the area of the jurisdiction of that Board, covering little more than one-half of the existing area of the companies' distribution, as well as for other reasons. The cost of delay of the measure (which measure was confirmed by the fire brigade committee) is enormous to the shareholders as well as to the public. As to the question of the eligible quality of water brought forward at the Congress, it is to be observed that those qualities are best tested by the effects of changes observed in prisons, and collections of persons in public institutions, which, when properly observed, leave no doubts on the subject.

Mr. John Towle (Oxford) said his subject was the Thames, and he felt confident that that river might be brought into London as pure as the Rhine from the Splügen. It came through a purely agricultural country until it got to Oxford, and there began the defilement of the river. Although that city was spending an immense sum of money on sewage, he did not believe it would do a farthing's worth of benefit, for he believed the sewage would ultimately find its way into the Thames the same as it did now. It ought to be taken away northward to a high reservoir, and put on to the land all the way to Banbury. Reading had been sewered at a great expense, and he was informed that the river was not a bit better. He was 84 years old, and had been studying this subject for 70 years, and had spent a fortune on it, and the conclusion he had arrived at was that the only way to purify the waters was to keep all the sewage out of them.

Mr. Murphy wished to get some further explanation

from Dr. Frankland, as to supplying water by meter. It seemed to him, that if that were carried out generally, a great injustice would be done to owners of property. In the first place, he would ask him whether he intended that water should be supplied by meter to all houses for domestic purposes, and he would remind him that landlords of small properties generally paid the rates for their tenants, the water-rate included. Now, if the water was supplied by meter, what protection would he give the owner against the waste which the tenants might commit under the meter system; for without some protection they would be placed at a very great disadvantage?

Dr. Frankland said he had nothing to suggest in the way of absolute protection of landlords, but it did seem to him that, of all people concerned in the management of small property in a town, the landlord was the most likely person to prevent waste amongst his tenants if he had to pay for it himself. He might also remark that, although there was no absolute method of preventing waste, there were very ingenious contrivances, called "waste preventers," which were applied to water supplied to courts and alleys, and he did not see why they should not be adopted where necessary.

Mr. Homersham said the surface of the globe we inhabit contains 197 million square miles; land, 53 millions; the ocean, 144 millions; the ocean being nearly three times the area of the land. From the briny ocean there is evaporated fresh water, which mixes with the air in the form of watery vapour, which, when driven inland by winds, is deposited as rain. Rain is the source of all water, whether river, lake, or spring water. When the rain falls on ground composed of clay or other impermeable rock, the water flows off the higher ground on to the lower ground, and is to be seen flowing down valleys, forming brooks, streams, and rivers, ultimately finding its way by gravity into the ocean. Beneath the surface, however, large areas of both hills and valleys are composed of gravel, sand, or thick porous rock, so absorbent that the heaviest rain sinks into the ground, and soon after is not anywhere to be seen upon the surface; the rain-water is all absorbed into the rock beneath the soil. The water so absorbed sinks till it is arrested by an impermeable stratum beneath the porous rock, when it accumulates in the pores and crevices of the mass of the hills, and at places saturates the rock to an altitude of four to five hundred feet above the sea, until, like surface water, it can find a subterranean channel through which, by gravity, it can force its way into the ocean. Heavy rains flow off high land which is impermeable at the surface, swell streams and rivers, and flood low lying lands. Heavy rains, on the contrary, are all absorbed into the land composed of a stratum of porous rock, and ultimately escape through subterranean fissures into the sea. I have here the drawings of nine pairs of bridges crossing different streams or rivers. One bridge of each pair has a drainage of ground composed of porous chalk, the other bridge crossing, as nearly as could be found, a similar area of drainage ground composed of impermeable clay. An inspection of these bridges will show that the water way for a bridge per square mile of chalk drainage is only one fifth to one tenth of the relative area of the water way of a bridge crossing a steam having a clay drainage ground. Here, then, we have proof that the rain does not flow off land composed of chalk, as it flows off land composed of clay. London to the north, north-east, and north-west is surrounded by chalk hills, the tops of which, distant thirty miles, vary in altitude from 300 to 900 feet. London to the south is bounded by hills the tops of which, distant sixteen miles, vary in altitude from 300 to 900 feet. Within convenient distance of the metropolis northwards, there are more than 1,200 square miles, and southward, more than 200 square miles of chalk hills, the greater portion of the rain, about 28 inches in depth per annum, falling on which could be easily obtained for the supply of the metropolis. Supposing, however, a quantity of water, equal to only a depth of 12 inches of rain over this area, be obtained, the yield would be 750 million gallons per day for every day in the year, or a mere fraction of the present supply to the metropolis. The quality of water derived direct from subterranean chalk and other thick porous strata differs in many respects from surface water, such as lake and river water. Subterranean or spring water obtained from chalk and many other geological strata, is, in its normal condition, characterised:—1. By having at its source an uniform temperature summer and winter, equal to the average of the climate of the year, which in this country differs but little, being about 50 deg. Fahr. 2. By being clear, transparent, bright, and when seen in large bulk, pure blue, the natural colour of uncontaminated water. 3. By being well aërated, and holding in solution eight or more cubic inches of gas per gallon, namely, two or more inches of oxygen, and six of nitrogen; by being pleasant, refreshing, and wholesome when drunk. 4. By being free from living organisms, vegetable or animal, and from all dead organic matter in suspension or solution. On the other hand, Thames, and most river water, after being passed through filters at waterworks, is characterised:—1. By having in the heat of summer a normal temperature of 68 deg. to 72 deg. Fahr., *i.e.*, 18 deg. to 20 deg. warmer than spring water; and, in the cold of winter, a normal temperature of 34 deg. to 36 deg. Fahr., *i.e.*, 14 deg. to 16 deg. colder than spring water. 2. By being more or less opaque, and devoid of transparency and brightness, and, when seen in large bulk, of that deep blue colour peculiar to spring and uncontaminated water. 3. By holding in solution, more especially in the hot weather of summer and autumn, a less quantity of oxygen gas than spring water, and being less refreshing and wholesome when drunk. 4. By holding partly in suspension, partly in solution, especially after heavy rains in hot seasons, manure washed from land, the droppings of animals and other fæcal and impure matters, solid and liquid; by abounding in life, vegetable and animal, and being liable to be inoculated by means of drains with the virus of specific diseases, and which virus often maintains active vitality, and causes ill-health and even death to those who drink it. Chalk itself is pervaded in every direction by numberless minute pores of aggregate capacity, sufficient to enable a cubic foot of dry chalk, of average quality, to absorb about two and a-half gallons of water, *i.e.*, four-tenths of its bulk. At depths varying from one hundred to five hundred feet (more or less) from the surface, the mass of the chalk below is saturated with water; that is, the pores in the lowermost mass are saturated with water derived from rain that, in the course of past centuries, has slowly percolated from the surface downwards. The chalk lying above this saturated strata varies from one hundred to four hundred feet in thickness, and in a normal state contains both air and water in its pores. A heavy rain, sometimes as much as two inches in depth in an hour, falling on the chalk hills, is at once absorbed into the soil, and the minute pores and crevices of the chalk at or near the surface. Chalk is a stratified formation, consisting of layers varying from one to two or more feet in thickness, reposing one upon the other, having thin spaces or interstices between each layer; it is also irregularly divided at many places by perpendicular and slanting fissures. The top of the uppermost layer of chalk is cracked or broken up, by the action of rain and frost, into comparatively small pieces. The rain is at once absorbed into these pores and cracks, and for the most part percolates gradually down into the mass below, until it reaches the lowermost layer or stratum. Chalk, owing to the minuteness of its pores, by mere capillary attraction, will retain a certain amount of water, which is diffused through it. Beneath the surface, the pores are partly filled with air, and partly

with water; when, however, rain falls on or reaches the top surface of a layer of chalk, the water, displacing the air, enters into the uppermost portion of the layer, and thus causes the water originally contained in it to pass out below and on the top of the next layer. In this manner water enters in at the top, and passes out of the bottom of each successive layer, and thus, in process of time, rain which falls on the surface slowly and almost imperceptibly descends into the lowermost layer or stratum. This very gradual percolation and passing down of the water through the mass of porous and creviced chalk is greatly assisted by a varying pressure of the atmosphere. When the barometer falls, some air makes its way out of the pores and the interstices between the cracks and lines of bedding. When the barometer rises, air makes its way into the pores and interstices. Porous bodies, such as chalk and charcoal, have the remarkable property of condensing oxygen into their pores; the oxygen in this state is known to enter into combination with other bodies with great readiness and force; owing to this property, and aided by the power of gases to diffuse, and the variation of the barometer, rain water, while sinking through subterranean strata, is effectually freed from organic matter, and absorbs or takes into itself eight or nine cubic inches of atmospheric air per gallon. A larger proportion of oxygen than nitrogen, however, is absorbed, as happens with pure water. This breathing of the hills, so to speak, with every change of the barometer, takes place during all seasons—spring, summer, autumn, and winter. Owing to this, the subterranean water attains the mean temperature of the atmosphere, and, as before explained, becomes effectually purified from all organic contamination; in consequence, it is clear, transparent, bright, well aërated and oxygenated, and becomes a pleasant, refreshing, and wholesome beverage. The chalk water, however, holds in invisible solution about $17\frac{1}{2}$ grains of chalk per gallon, or is $17\frac{1}{2}$ deg. of hardness by Clark's scale. This renders the water what is popularly called hard, and ill adapted for washing and bathing. By a simple and inexpensive process, however, invented by the late Dr. Clark, of Aberdeen, the chalk in the subterranean water supplied to Canterbury, to Aylesbury, to Tring, and very many other places, is withdrawn from the water before it is supplied to the consumers; and this process, after 25 years' experience, has been found both cheap and easy to apply in practice. Why, then, should not all London be supplied with water derived from subterranean chalk strata softened by Clark's process, instead of surface or river water, filtered through a layer of large grained waterlogged sand? The only reasons that have been urged against this being done that I know of are two:—First, the pecuniary loss that would accrue to the shareholders of the eight companies that now supply London, if competition were allowed; second, a suspicion that uncontaminated water thus derived direct from the subterranean chalk strata would somehow be abstracted from springs that now issue above the level of the sea and flow direct into the River Thames, the River Lea, and their tributaries. I hope what I have said has satisfied you that there is no substantial foundation for such a suspicion, and I am sure if I had more time I could convince you on this point. For the sake of argument, however, supposing such to be the case, would it not be more sensible to abstract the water indirectly from the rivers before it becomes polluted by admixture with the fæces of the million human beings that reside on the drainage ground of the Thames, and the numerous population that reside on the drainage ground of the River Lea, than to endeavour to separate such impurities, solid and liquid, from river water before supplying it for household consumption? Remember that those who are most loud, and now make, and have heretofore made, most noise about the proposition to supply London with unpolluted wholesome water from the chalk strata, are paper and other manufacturers having works on the banks of the streams, and who themselves obtain and use subterranean water for their own manufacturing purposes, and who, after they have thus dirtied or polluted the water, discharge it into and foul the streams. Since attention was directed to the chalk strata as a source for the supply of the Metropolis, Plumstead, Woolwich, Charlton, Greenwich, Blackheath, and a large district south of London, have been wholly supplied by wells sunk in the chalk strata. Brighton, Canterbury, Great Grimsby, Hull, and other important towns, have got the whole of their supply from this strata, and their water is becoming gradually superseded by subterranean water for domestic supplies; and if we look across the Channel we find Paris has also obtained a large portion of its supply from the chalk strata.

Mr. Spencer asked if Mr. Homersham had considered, on physiological grounds, whether the softened water so highly recommended was more wholesome than ordinary hard water.

Mr. Homersham said he considered soft water, for many constitutions, better than hard, and for all constitutions, quite as good. A statement had been foolishly made by some chemists that bone consisted of carbonate of lime to a certain extent, and that you must get the lime from the water, but the fact was there was very little carbonate of lime in bone, it was phosphate of lime and, in Aberdeen, where the water had less than one degree of hardness, and in Glasgow, where it had only $1\frac{1}{4}$, the people had just as large bones as in other portions of the country.

Mr. Spencer said these platitudes about lime in bone had been often repeated, but that was no answer to his question, whether, on physiological reasons, the conducting of nervous power was better carried into effect by soft water than hard. In the laboratory they knew it was not a conductor at all.

Mr. Homersham said that Canterbury had been supplied for seven or eight years with soft water, and the people were very much more healthy since then than they were before; and he could mention a dozen places where it had been in use for 10 or 12 years, and where the people's health had improved.

The Chairman said Mr. Spencer must get this question settled by some medical expert.

Mr. Homersham added that spring water softened was very different to the water from Loch Katrine, or any other lake, which had a great many sources of impurity from organic matter, whereas this softened spring water had no organic matter in it.

The Chairman asked Mr. Homersham if he could give any opinion as to the question of meters in private houses.

Mr. Homersham thought there was a great mistake about the application of meters to private dwelling-houses. Take the West-end of London—there were many houses there let for £700, £800, or £900 a year, which were unoccupied for more than six months, during which time the water was absolutely cut off to prevent leakage or breakage from frost; still the water company had to lay the pipes to these houses, and the interest on their capital was going on, whether the people took the water or not. The fact was you did not pay for water as you did for gas, which had to be manufactured; it was the laying of the pipes and the conveyance which had to be paid for, and that had to be paid for whether you took the water or not. You could not be paid by quantity. He had a large district under his charge where every house had a meter, but there they had a minimum charge. They could get no water for their cattle, or gardens, or other purposes, except from the water-mains, and therefore the company put down meters, charged the consumers a minimum rate, and if

they took more than a certain quantity they paid the excess, and this plan was found to answer very well. If you took small houses and cottages, and put a meter in every one, it was liable to get out of repair, and the meter would cost as much as the water supply.

Mr. Turner asked whether, in the case of the people who were charged extra for water to supply their gardens, the Company rated the house alone, or the house and garden? because, he contended, that if the house and garden were rated, the tenant was entitled to the use of the water for the garden.

Mr. Homersham replied that the water companies were obliged to charge in conformity with the Act. They rated simply according to the Act of Parliament, and that did not allow water to be used for garden and other purposes. He could quite bear out what Mr. Chadwick had said as to the waste of water. In the summer time, they did not find that people took more than 16 gallons per day, and in winter not more than 12, though there was a constant supply, and they could take what they liked. He disagreed with Mr. Chadwick, however, as to the necessity for the water being in the hands of a Corporation to prevent waste. He could mention several companies under his own charge which gave consumers a constant supply, and where much less was used than in Manchester, Liverpool, or Glasgow. In Glasgow an enormous waste went on. In fact, he considered it a moot point whether private companies would not supply water cheaper and better than a Corporation or public body.

The Chairman being obliged to leave for a time, his place was taken by **Mr. Edwin Chadwick.**

Mr. Hassard then read, and somewhat amplified the paper which he contributed.

Mr Baldwin Latham wished to make a few remarks on something which transpired yesterday. A report was then quoted, in which Mr. Robert Rawlinson was rather severely handled with respect to his observations on the quality of water, wherein he stated that chemists were totally unable to arrive at a correct conclusion of what was wholesome and what was unwholesome.. He thought he used those words advisedly, because chemists said water was pure or impure, and judged of it by certain standards they had set up, and he thought, after he had read a passage from some of Dr. Frankland's own reports, it would be found that Mr. Rawlinson was quite correct in the conclusions at which he had arrived. On the 5th of January, 1877, Dr. Frankland reported on the quality of water supplied to London for the previous December. He then said that, during that time the Thames was in high flood, and during the whole of December, its water was loaded with organic impurities of the most disgusting origin, and its efficient filtration was exceedingly difficult, and even when efficiently filtered, the water was quite unfit for domestic use. The report in the following month was to the same effect. That being the report of one of the ablest chemists of the day, it was rather a significant fact that, during the whole of that period, when this water was supplied to London, the Registrar-General was reporting that the health of London had never been surpassed, and that all classes of disease were a long way below the average. Taking that fact in conjunction with the evidence given upon the Middlesbrough Water Bill by Dr. Frankland, it was quite impossible for chemists to arrive at a conclusion as to what was wholesome or unwholesome. Dr. Frankland was there asked if he thought it unsafe to supply a large population with water impregnated with excreta of patients suffering from various diseases, and he said he did, although chemical analysis would fail to detect anything unusual in that water. He added that he had himself mixed one volume of the dejecta of a patient dying from cholera with 1,000 volumes of good water, and on submitting it to analysis, had been unable to detect anything unusual in the water; in fact, chemical analysis was unable to detect those small quantities of morbific matter which were calculated to transmit diseases to people drinking the water. It followed, therefore, that if the water had been submitted to Dr. Frankland for analysis, he would have pronounced it perfectly wholesome. On the other hand, it was well known, and the facts were recorded in many instances, that typhoid fever especially had been disseminated by water, and the analysis of the very sample which was proved to have caused the outbreak, showed it was far purer than other water supplied in the same town. These facts were quite sufficient to show that Mr. Rawlinson was correct in the evidence he gave before the Select Committee, and he was sorry anything should be said contrary to his view, as he held a very important position under Government, and those who were brought in contact with him must know he had an opportunity of getting a large amount of information by direct observation. With regard to the scheme described by Mr. Homersham, he claimed a great advantage for it, that the water was of equal temperature. Now, he lived in a town who was supplied with water from the chalk, and for two years he had determined the temperature every day of the water supplied to his house. It was quite true that the water in a well did not vary more than one degree from year's end to year's end, but it was a very different thing when you came to distribute it to the houses. In fact the temperature was that of the ground at about the depth of three feet below the surface. In the winter time the mains were refrigerators, which cooled down the water, and in the summer they were an apparatus by which the temperature was raised. Last summer, which was by no means a hot one, the water supplied to him was 66, and in the winter it had been as low as 38. Therefore, all these supposed advantages derived from this uniform temperature were *nil*. A great scheme had been put forward, prepared by the Metropolitan Board of Works, with reference to taking the water supply from the chalk; and he was surprised to hear Mr. Homersham say that you could pump even a limited supply without affecting the surface wells. He had been engaged in investigating this matter for a large number of mill-owners, who had property on the various streams around London, and having had the opportunity of making tests with reference to the influence of pumping on the streams, he could state without hesitation that you could not take one million gallons of water out of the water strata by a well without diminishing to that extent the volume of water which otherwise would flow out by the natural streams. It was another fallacy to suppose that this water in the ground was held in some subterranean reservoir which might be drawn upon *ad libitum*. His observations, extending now over some hundreds of square miles, showed clearly that, from May to nearly the end of November, as a rule, the underground springs received no accession of water from the chalk area, and that during the whole of that period the water, which had been stored in the winter months, was gradually exhausted, and the real replenishing of the springs entirely depended upon the winter rain-fall. To show the correctness of this view, he might mention that for two years running he had been able to tell the exact day when a spring would break out in the Caterham Valley. Knowing the rate at which the water was rising in the ground, he could foretell the day and place where these underground spring would break out. These waters in the chalk were almost entirely due to the rainfall of the winter months, and it was the rainfall of a particular year which affected the supply, and not the rainfall which had fallen, as they had heard from Mr. Homersham, some centuries ago. He had heard that gentleman say they were drinking the rain which fell in the time of Charles II., which was absurd. The wells

shewed immediately by their fluctations, by their acquisition from large rainfalls, and depression in times of dearth, that cause and effect were united. If there was a great fall, there was a large quantity in the springs, but it was not permanently stored there. In the year 1876 the springs in all the chalk districts received the greatest acquisition of water we had had for many years. Where a large quantity of rain fell to replenish the springs, a large quantity ran off, and at the end of the period there was but a slight excess, as there had been this year. But, as a rule, a large quantity of rain falling on those chalk downs was not stored permanently. With regard to these schemes, he thought the interest of the millowners ought to have some consideration. Here were special trades located on all these streams, the paper trade especially, who had settled there on account of the value of the water for their particular purpose, and if their supplies of water were taken in this surreptitious manner they must suffer, and in the result millions of property would be sacrificed, whereas no permanent advantage would accrue to any one.

The Chairman said the Bill was withdrawn.

Mr. Baldwin Latham said he knew it was withdrawn for the present, but the engineers were still going on completing the survey, which meant that it was only deferred until some future day. You could not take a drop of water from the strata without affecting the volumes in the springs; but such was the state of the law, that water could be taken in this surreptitious manner, to the ruin of property, without one farthing of compensation being paid. He contended that such was the state of science that they could now say with regard to subterranean water what its sources and direction were, with as great certainty as they could with regard to the streams which flowed on the surface, and, therefore, an amendment of the law was required with regard to underground water, so that those who had property in it might have the same security as those who had rights of property in streams on the surface.

Mr. Homersham said you might spoil anything. The temperature of the water taken into a town would depend on the depth at which the pipes were laid. He generally laid the pipes four feet deep, and the temperature was maintained within a few degrees summer and winter. Again, you might construct a well so as not to affect surface springs near it, if you did it properly. With regard to the law, it was the same here as in France. He rather gathered that Mr. Latham had a retainer against the Bill of the Board of Works from some mill-owner.

The Chairman said Sir U. Kay-Shuttleworth had stated that if these Bills were brought forward he should be obliged to speak against them, and he knew positively that the opinion of the Government was decided against the Board of Works plan, and it was not likely to be altered if they renewed it

Mr. Latham thought it only applied to this session.

The Chairman said of course they could bring forward anything they pleased in any session, but that the Government would oppose the Bill on the ground of jurisdiction and other grounds, apart the question of source, he had no doubt.

Mr. W. S. Mitchell said Mr. Latham had drawn attention to the use of the adjectives "wholesome," "unwholesome," and "pure," in respect of water, and that was a very important matter. In the early times of water investigation, when our knowledge was very inexact, these vague terms might have been used indiscriminately, but our knowledge was now getting much more exact, and it would be a great advantage if we attached a more definite meaning to them. As for pure water, every one knew we did not get such a thing out of the laboratory, and wholesome water was a water which, perhaps, we did not know much about. Sewage contamination was another thing, and absolutely unwholesome water was a different thing again. He would not offer any suggestion himself what the distinction should be, but as Mr. Latham said he was obliged to use these terms somewhat vaguely, he hoped the matter would not be allowed to drop through, but would be considered as it ought to be. Mr. Latham also said that chemists were unable to tell what water produced disease and what did not. That he believed was the case, and he should suppose it was not for the chemist to decide whether a certain water would produce disease. If he understood rightly the duties of an analyst, they were simply to pronounce chemically as to the state of the water. He imagined the same remark would apply in some degree to medical men, that they did not know what waters would produce disease and what would not, except such things as direct poisoning, cases of goitre, and so on. The committee, in making arrangements for this Conference, sent out a number of questions to officers of health and sanitary authorities throughout the country, but in the book circulated only the answers to the first four questions were printed. The other questions were these—"Can you give any information of any disease, other than recognised epidemic diseases, being caused by a particular water?" "Can you state whether water that has once been contaminated by sewage is fit to drink; if it is, to what extent must the sewage be diluted?" The answers to those questions were but very few, the total numbers received altogether being 100, but only 12 gentlemen were able to give any information whatever on these subjects. That was a matter worth noticing, that the medical officers and sanitary authorities were utterly unable to speak positively, from anything within their own knowledge, as to water being the cause of disease other than recognised epidemic diseases.

The Chairman said they had been asked for physiological tests, but he thought the test of the stomach was one which could be applied in large institutions. In one prison an outbreak of dysentery suddenly occurred, and on sending down to inquire, it turned out that the prison drain had broken into the prison well. Again, for a time, the prisoners in Milbank were supplied with water taken from the Thames, and during that time they were subject to attacks of typhus, but when the water was changed it ceased, and the institution became, as such generally were, a great norma of health; and since the water had been obtained from Trafalgar-square the health of the prisoners showed a great advance over that of previous years.

Mr. Spencer asked if that was not very hard water?

The Chairman said it had about four degrees of hardness. If this had been an isolated case the physician would not know the cause, but where large numbers of persons were collected together, it could be clearly traced. He had no doubt that what Dr. Frankland could not detect chemically, would very soon be detected by its effects in such an institution.

Mr. Pearsall asked if the question had been fairly stated with regard to hard and soft water. He believed it was time, because a great deal of the water from the chalk, especially that which had been named, in Trafalgar-square, contained a considerable quantity of soda, so that it was no longer a case of soft water but hard water if you got a substance like soda with it. He also believed that water which would answer very well in one state of health would not answer in another, and, again, it would differ in its effects when used for domestic purposes and boiled. Again, he remembered that in one of the epidemics of cholera in London, it was perfectly well-known that, at the East-end, on one side of a certain street people died very rapidly, whilst on the other there was not a single death, but they were both supplied with the same water. Most of those

people were Jews, and they were said to be very dirty. They took up that question, and pointed out that they were not really dirty people, but were cleaner than their neighbours.

The Chairman asked if there were not two different water supplies?

Mr Pearsall said no, they were both the same.

The Chairman remarked, according to his recollection of those people who were attacked, hardly any of the adults were water drinkers. Another fact was, that in the same locality there was a great school at Limehouse, and, though cholera was raging all round, there was no case of cholera within the school. That was supplied by the New River Company.

Dr. Vacher (Birkenhead) said Mr. Mitchell laid some stress upon the fact that no answers had been received to the question asking if any diseases, other than those usually called filth diseases, such as diphtheria and typhoid fever, had been known to be derived from impure water. The difficulty medical officers found in answering that question was that of eliminating all other causes. In those districts where you had the most disease, you found there was not one factor but several to deal with. The people were over-crowded, ill-fed, very often under-fed, vicious, and dirty, and then, besides that, they had an impure water supply. There were six distinct factors, and a medical officer knowing that, would be a very bold man if he put aside the five, and said that the disease had arisen, in any particular case, from drinking impure water. He thought Mr. Latham had laid too much stress on the evidence as to the character of water obtained from chemists. Chemistry was very good as far as it went, but it did not do everything. People who were very desirous to obtain a satisfactory opinion on water would submit it in the first instance to a chemist, who would ascertain how much nitrogen there was, and they could then form an estimate of its purity; but if they were very careful they would submit it to a biolgist, who would carefully examine it under the microscope; and setting aside altogether the question whether at present we knew what particular morphological elements there were to be found in water contaminated with cholera and enteric fever, he thought, at all events, that if one thousandth part of the dejecta of a patient were put into water, and it were examined under the microscope, you would at all events find some portion of the *debris* of the intestines which would lead to the conclusion that the water was so contaminated.

Mr. Conder asked Mr. Hassard whether his attention had been turned to the bearing of his system of water supply upon the defence of the country. If any hostile force could get possession of the aqueduct, where would London be?

The Congress here adjourned for luncheon.

Mr Austin having spoken at great length in favour of the artesian well system, and described a method devised by himself for improving the construction of such wells,

Dr. Elliott (Carlisle) said there were certain broad questions which it would be well to hark back to. One was what really was the most natural source of our water supply for large towns? After so many speakers had given their opinions, it was unnecessary to go into minute details, but he would summarise his answer to their questions by saying that it was not pure water, such as an analytical chemist would describe it, that was required nor could they get it; nor was it the hard water of the fountain. Viewing the question from a sanitary point of view, they should neither give principal attention to lake nor yet to the fountain, nor in some cases to a deep sunk well. In fact, wells of all kinds, if the soil were at all reachable by impurities, gave the worst sort of water you could have. In all arrangements for a town supply of water, it was impossible for the workmen altogether to avoid the use of lead; and this had so frequently led to disastrous results, that it at once pointed out a great objection to lake water, if that were chiefly relied upon, because lake water had a peculiar power of acting on lead. It would not do to keep water for any length of time in lead cisterns, or standing in leaden pipes.

The Chairman reminded the speaker that the pipes might be made of iron or of earthenware.

Dr. Elliott said either iron or earthenware was difficult to work in comparison with lead. In small towns the use of lead, at some stage of the apparatus, was almost inevitable.

The Chairman said there were about 17 towns which had been supplied with iron services as well as mains.

A Gentleman said that at Bournemouth lead was not allowed to be used at all.

The Chairman said this was the case in Odessa, where his son happened to be engineer to the water works.

Mr. Elliott said there were few difficulties which might not be overcome; but still that was a great difficulty. After a long experience in this work, he could quote a large number of cases of disastrous effects arising from carelessness of work, and it was very difficult for those who had the charge of the health of the people to watch sufficiently closely the workmen when doing their work. In his town, where the river supplied a fairly soft water, having only 7 deg. of hardness tested by Clark's process, they had a security against the action of lead, and so they had in most river water. It was immediately lined with a varnish or coating of sulphate of lead, and put an end at once and for ever to any action of the lead composition of that pipe on the water which it conveyed. A question had been put as to what disease other than epidemics might arise from organic pollution, which he might answer by saying that he had frequently met with cases of a disease common amongst children, namely, the presence of entozoa, or worms, which was distinctly referable to organic pollution in the water. More than one speaker had gone the length of saying a word against the riddance of our rivers from pollution, at least, so far as to speak of capitalists and manufacturers as having a very strong claim indeed on the attention of the country at large, on the score of damages, in case they were compelled to keep that refuse out of the river, which, at present, was allowed to flow into it. As to organic pollution, he thought enough had not been said, and could not be said, against the pollution of rivers on this score. It entailed an enormous loss to the kingdom of a useful fertiliser. We were wasting every year in this country an amount which would be perfectly fabulous, if we were to reckon it up in the amount of sewage given to the rivers, and so finding its way to the sea. At Carlisle they had been delivering sewage on to land of a gravelly porous character, with very great benefit; in fact, they were doing, on a small scale, what had been done at Edinburgh, where land otherwise worthless was, by the distribution of town sewage, made so valuable that its rental was from £30 to £40 per acre. Why the same thing should not be done elsewhere he did not know. In Carlisle they had tried the same experiment with perfect success, though at present their operations had been discontinued in consequence of railway alterations, but the land was improved and brought to double its previous value. Another evil arising from the pollution of rivers, by chemical or inorganic matter, was the loss of fish, which in inland districts was a matter of considerable importance, not only as a source of food supply, but also as affording a popular and healthful pastime.

The Chairman said he had been told that at Carlisle, in consequence of the sewage being discharged fresher than usual into the river, the fish, instead of being killed, became finer than before.

Dr. Elliott said the River Eden was one of the best salmon rivers in the kingdom, and the salmon was perhaps the greatest epicure amongst fish. He did not require a better certificate of the water in any river than to find that salmon abounded in it. The Eden was not only amongst the best salmon rivers, but one of the three earliest.

The Chairman asked if it were true that the fish had improved since the discharge of fresh sewage?

Dr. Elliott said, when sewage was fresh and exempt from germs of disease, it carried nothing with it unwholesome. It was when it underwent putrefactive fermentation that it became injurious, quite independently of germs of disease. All fish lived on animal food, in fact they lived on each other, and it was a continual round of destruction, from the smallest creatures to the salmon itself. It must not be supposed that because they spoke of excreta thrown off from the animal economy, that therefore it had no use in nature. He did not think it was necessary to attempt the introduction of sewage into rivers for the sake of improving the quality of the fish; it would be much better to keep it out of the rivers and give it to the plants. He was not prepared to answer the Chairman's question off-hand, but it was perfectly possible that recent sewage, free from disease, might afford a supply of food to the smaller fish on which the salmon fed.

Mr. Spencer remarked that all diners at the "London Tavern" or Greenwich had found that the whitebait was nothing like so good now as it used to be when the sewage was thrown into the river.

Dr. Frankland said with regard to the action of water on lead, that the City of Glasgow was supplied most undoubtedly with Loch Katrine water, and that was, of all waters in the world the one which acted most violently on lead, whether bright or tarnished. This was known before the water supply was carried out, and the medical men of Glasgow were on the look-out for the effects, but they had never reported any case of lead-poisoning in Glasgow.

The Chairman said some of these fresh waters deposited on the lead a film, which for a time protected the pipes. With respect to Glasgow, his information led him to believe that the people were aware that there was lead contamination, and that one cause of the great waste of water in that town was that every morning they let large quantities run through the pipes, in order to avoid this danger.

Mr. Hassard wished to answer a question put, before the adjournment, by Mr. Conder, with reference to the national defence. The same remark would apply with greater force on the Continent, but there it was not allowed to prevail. Paris was supplied by aqueducts 160 miles long, Marseilles by one 90 miles in length, Vienna by one 36 miles in length, and Madrid by one of 40 miles. Besides, the aqueduct would be almost altogether in a tunnel; or, at any rate, not easily accessible. If this country were occupied by a hostile force, unless London were surrounded by a huge system of fortifications, extending beyond all the intakes of the water companies, the same objection would apply. With regard to action on lead pipes, he might say that in Dublin, where the scheme was projected and designed by him, and the water was equally soft with that of Glasgow, and equally pure, it was found that an alloy of 2 per cent. of tin mixed with the lead effectually prevented all action of the soft water.

Mr. Spencer said his information with regard to Glasgow did not quite agree with Dr. Frankland's. He was consulted at the time of the new works by the Glasgow Corporation, and he had the care of the Whitehaven Water Works, where they had softer water even than that of Loch Katrine, it having only $\frac{3}{4}$ deg. of hardness. A commission was appointed by the Corporation of Glasgow to visit the soft water supplied towns of England, and very naturally they went to Whitehaven. Professor Penny objected to the Loch Katrine supply on the ground of it being too soft; but when they examined the Whitehaven water, they did not find one instance of disease in consequence of the lead, and that rather decided the Glasgow people to go to Loch Katrine. That was the fact, no doubt, but what was the cause? In Whitehaven they had no meters, and the waste of water was enormous. About 305 gallons per day were consumed by those people, in fact they would soon have drained the lake. But the mains soon became defective, and he was called upon to report upon them, and he found that, whereas originally they were of 9 in. capacity they were reduced to 3 in. or 4 in. On examining them, he was astonished to find that there was no lead poisoning; but some of the lead pipes had a nice brown coating of protoxide of iron, which had been dissolved from the iron mains and deposited upon them, so that the people saved themselves from disease at the expense of the pipes.

Mr. Symons asked what was the deposit, which amounted to something like two inches thick in those mains?

Mr. Spencer said it was magnetic oxide of iron.

Mr. Homersham thought it was a vegetable growth inside the pipe rather than an oxide of iron.

Mr. J. M. Cox (Medical Officer for Mid-Cheshire) said he had sent in his name as having some knowledge of the supply of water to be obtained from the lake district, having been medical officer there for some time, and he feared that the able paper read on that subject in the morning would pass with very scanty comment. Many people were unaware of the immense amount of water continually running off the lake district of Westmoreland and Cumberland, but it was stated, on the authority of Mr. Isaac Fletcher, Member for Cockermouth, who was a Fellow of the Royal Society, and a scientific man, from observations he had made, that the River Derwent delivered more water to the sea in the course of the year than any other river in England. That would show what an amount of this excellent water was continually running to waste. He was glad to hear the observation of Dr. Frankland on the advantage of economising water, and on the danger of letting the water, even in single households, run to waste, and it occurred to him, what a capital argument that was for utilising water on a large scale. If it were a disadvantage for water to be wasted in a single house, how disadvantageous it must be to a country where the water was of such great importance, for the water of an entire district to run to waste. It was mentioned by Mr. Hassard that an objection was raised in the Manchester inquiry, which was called the "sentimental objection," and he might assure the meeting that that objection was really worth nothing. It was not sought to utilise those waters by discharging noxious matters into them, but in such a way as to preserve all their purity, and the preservation of the purity of the water of the lake district was not by any means a matter which was unconnected with the sentimental treatment of this subject. It had been his duty to report again and again that riparian owners on the shores of those lakes committed the most serious nuisances with no consideration whatever, even draining their water-closets, and very frequently their slop waters, into them. Now, the utilisation of those lakes on any large scale would tend to put a check to all that. He admitted that a check was provided in existing statutes, but they wanted all the checks they could get, and, even from the sentimental point of view, the use of these waters for drinking purposes would be a great benefit. The injury caused by these waters running to waste like wild horses, as was said yesterday, was very conspicuous, and the value of the land was much depreciated in consequence. The hay crop

was very precarious in the lake district, because the outflow was under no control, and not only was there a loss of vegetable produce, but there was great injury to the public health. He had not the figures before him, but he could produce them, showing that the death-rate from consumption, a disease which was very much produced and developed by dampness of the foundations of houses, was much larger in the lake district than in other parts. It might be said the rainfall was excessive, but they should protect themselves against that by drainage; and his contention was that the increase was due to the immense storage of water in the ground from the immense accumulation of superfluous water. Again, if you looked at those lakes, was there any great appearance of regard being paid to the ornamental aspect of the shores? He should say, decidedly not. The most ornamented water was Derwent water, but its beauty did not consist in the appearance of the shores but in its volume, and the beautiful disposition of islands upon it. That God had done; but when you come to what man might have done, you found that the shores were nothing more nor less than a morass. It was, therefore, unfair for those who lived there to say that you should not put a hand on those waters; at any rate until they showed some disposition to preserve and promote their picturesque appearance. They said it would spoil the Lake District. Now, last Sunday week, he took a walk on the High Rays, a mountain between Grasmere, Thirlmere, and Derwentwater, and standing on those immense altitudes, looking down on those sheets of water, he thought how impossible it was for the action of any engineer, or any Corporation, to interfere with the beauty of that district. It was really too absurd. This district was too vast for any such effect to be produced. The beauty of the lake district must for ever remain, in spite of any interference which the Society would tend to encourage. With regard to the quality of these lake waters, he had had considerable experience, and could have brought a sample of a leaden pipe which had been in use at Whitehaven for 14 years; but the whole of the information required on the subject of the relative effect of hard and soft water on lead pipes was to be obtained in the last report of the Rivers Pollution Commissioners, and it seemed almost like wasting time to hear what was said at meetings of that kind, as if no such production had ever been in the hands of the public. This coating was partly chemical and partly vegetable. It seemed somewhat paradoxical, but the more water acted on lead the less it acted. The more it acted the sooner it coated the inner lining with this peculiar product, and when once this was established it remained for ever as a protection against any further action. He would bring a specimen of the pipe to-morrow, showing that the calibre was not diminished in the slightest appreciable degree. All the medical men in the neighbourhood were aware that this soft water had never been the cause of any injury from lead whatever. He knew an instance where the water had been stored in a lead cistern, the inside of which was coated in the same way, and no trace of any injury having occurred could be heard of. Therefore any fear of the action of soft water on lead was quite needless.

The Chairman said they had heard of numerous cases of injury by lead; for instance the death of Louis Phillippe was attributed to that cause. The water was supplied to a lead tank, into which leaves and vegetable matter fell, and the result was to set up an action which Dr. Frankland would recognise, and the illness and death of that king was ascribed to that cause. With regard to a plan proposed by Mr. Hassard, it was a very grand scheme, and these grand works were very much admired; but in London, certainly at the present time they had an adequate supply, and more than double the actual consumption was certainly obtainable from the Surrey springs, at an expenditure of probably a million and a quarter. There were difficulties in making collections connected with the possession of the different lands required to be taken, and it was very convenient for an engineer to take one great source, and perhaps to bring the water from it to all large towns; but the fact was, the committee of that Society had considered this a good deal, and their conclusion was quite unanimous that the first thing to be done for the metropolis, before any new supply was thought of, was to put the existing supplies and the existing distribution on a public footing; to put the existing distributing apparatus in a right condition, and to diminish the enormous waste. When that had been done, then the authorities in possession would be in a condition to judge of how much more they wanted, and in what direction to look for it. But they ought not to complicate the question by going into new supplies, which would only waste effort and embarrass the whole question. The Metropolitan Board of Works, who had gone into a new scheme, had brought on themselves the opposition of 50 petitions, and about 100 counsel had been employed fighting the question. He thought they were mistaken as to their source of supply; but be that as it may, that was entirely premature. The only right course was to put the matter on a public footing in order to get an impartial determination. The conflict about new sources was interminable, and during all that time enormous waste was going on, all of which could be prevented at once by getting possession of the existing works.

Mr. Homersham—At what cost?

The Chairman—At a reduced cost. The Honourable Randolph Stewart had gone most thoroughly into the matter, and he might tell them a secret, that it would be at a reduced cost. The cost of purchase would be 30 millions, giving a very liberal compensation, or on the basis already sanctioned by Parliament in a number of cases, 26 millions. Instead of it being a burden on the people, it would be a reduction of burden, by the economy of consolidation. The economy in this way in administration alone would be about £120,000 a year, and by reducing the waste of water, that would save the pumping of 60 millions of gallons per day, and that, it must be remembered, would not only be a saving in pumping the pure water into London, but in pumping the polluted water out again. Then the eight directorates cost £17,000 a year, and about £20,000 or £30,000 would be saved in collection of rates. The result was that, paying shareholders what they claimed to be entitled to, they would still have enough saved to put hydrants in the streets, and leave an increasing surplus of economy.

Mr. Homersham said the waterworks had cost 12 millions, and if they were to be bought for 26 millions, he did not see where the economy was.

Mr. Condor asked if the New River shares were counted in the computation? because, in the Government returns, the capital was put at 13 millions; but, at the rate at which some stock recently sold, it came to between 11 and 12 millions, including 25 per cent. for compulsory purchase.

The Chairman said he could not go into those details, but the New River was included. Parliament had settled definite terms of sale in different cases, those terms being 25 years' purchase of the maximum dividend, with an allowance for prospective advantage.

Sir Henry Cole here resumed the chair, and **Mr. Prestwich** read his printed paper.

Mr. Chadwick asked if Mr. Prestwich could name any instance of favourable results from the sinking of these deep wells, because he himself knew of numerous failures, but not one of success.

Mr. Prestwich said it had not been tried in London but in Paris, where wells were sunk at Grenelle and

Passy some years ago; the water still continued to flow in a large volume and of perfectly good quality.

Mr. Chadwick said he had been told that the quantity was just sufficient to serve for shaving water, and they had gone some 63 miles off to get the supply.

Mr. Prestwich said the quantity was not large enough for the supply of a large town, but it could be used as drinking water.

Mr. Homersham asked if Mr. Prestwich had specially examined the Trafalgar-square well, which was sunk 25 years ago, to supply a moderate quantity of water, but was now supplying three times the quantity it did. He had had occasion to examine it three years ago most minutely, in order to give evidence about it, and he found that the water stood at about the same level as it did when first sunk. Mr. Prestwich had treated the lowering of the water in the chalk under London as a universal thing, but here was a specific instance where it had not lowered. He did not say there were not certain wells where the water had lowered, but it was not universal; for if they examined some of the wells at Greenwich and Deptford, they would find them standing at exactly the same level, a little about Trinity high-water mark. He sank a well, 20 years ago, near Plumstead, which had been continuously pumped for years, and still stood at about the same level.

Mr. Prestwich said he had no data before him, but the fact of the general lowering of wells since the first artesian well was sunk in London was well known. The water from the first well rose above the surface, but it had been sinking from time to time, and the level now stood at 60 or 70 feet below the surface. He knew of no exception to that rule in the case of a true artesian well in London. Beyond the tertiary basin, in wells sunk into the chalk, where it came near the surface, the water might be maintained with much greater fixity.

Mr. Conder said the water in the well at the Bank of England had been subsiding year by year, and fully bore out Professor Prestwich's remarks.

Mr. Cresswell asked if Mr. Prestwich knew Richmond, and was aware that several wells had been there sunk within a few miles of each other. Some years ago, the Duke of Buccleuch sunk one in the grounds of his villa; more than 30 years ago, one was sunk to supply the old brewery which was now the site of the proposed water works; and within his memory another had been sunk at a large brewery at Isleworth, the greatest distance between any two of these wells being about two miles. He believed it was a fact that the level of the water in those wells had considerably altered during the last 25 years.

Mr. Prestwich said his observations applied to all wells sunk through the London clay into the chalk, and would include those at Richmond.

Mr. Cresswell added that when the well was first sunk at the brewery, the water rushed up to the surface and overflowed, but for the last 20 years it had sunk something like 120 ft. This was considered by the local geniuses to be caused by the sinking of the well in the Duke of Buccleuch's grounds, and the level of both was considerably affected by sinking the well at Isleworth.

Mr. Homersham said he examined the well at Richmond two years ago, and it over-flowed then, rising considerably above the level of the Thames, so that the statement just made was incorrect.

Mr. Baldwin Latham, having made a number of observations only recently on the wells within the London area, said he could quite confirm every word Mr. Prestwich had said with reference to the diminution of the water. One of the most remarkable cases was at Hanwell Lunatic Asylum; when it was first bored, the water used to flow into a tank 30 ft. or 40 ft. above the ground, which supplied the whole establishment, but the water had since so diminished in force that at the present time it had to be pumped into the same tank. In all the large area covered by the tertiary beds, the water had to flow from the natural outcrop of the chalk, a considerable distance, to these wells, and it was exactly the same as water flowing through a pipe. If a given quantity had to flow through a channel, and the exhaustion upon it was very great, the pressure diminished; as the wells increased throughout the covered area, and the water supply was tapped, naturally the pressure was diminished, and the consequence was the water did not rise so high as before. He did not say there was not so much water there, because that depended on the fall of rain on the outcrop of the strata, and would vary from year to year, but the pressure certainly diminished. With regard to the Charing-cross well, there was a great underground depression corresponding very much with the line of the River Thames. It naturally followed, therefore, that if exhaustion took place in the wells in that natural depression, the strata having a direct communication with the Thames, infiltration of water from the Thames would take place, and, therefore, the level of the water in wells nearest to the Thames would be much more affected than those more remote. It had been established beyond a doubt, by the different quality of water in wells near London-bridge, that this infiltration took place from the tertiary beds, which covered the channel of the Thames, and even the chalk, which made up, to a great extent, for that exhaustive power which was, year by year, increasing in London.

Mr. Shepherd said it had been put forward that water was the cause of all diseases, while some said that sewage produced disease; but he had recently discovered a new law of light, which he had been working at for years, which clearly showed the operation of light in producing plague, pestilence, and famine.

The Chairman reminded Mr. Shepherd that the question under consideration was water, not light.

Mr. Shepherd said there was no finer water in the world than the Thames. The sewage ought not to be put there, but on the land; but still it was a mistake to suppose that water communicated disease.

Mr. Charles White (Lambeth) thought the cistern required greater supervision; for instance, where a house is tenanted by lodgers, no one was responsible to clean it, and it was somewhat similar to the question "who should clean down the staircase?" Persons of this class in too many cases would almost prefer using impure water than take the trouble to clean out the tank. Another great evil was the waste-pipe communicating from the cistern with the pan of the closet; it was only lately discovered to be the case in the house in which he (the speaker) resided, and he believed there were thousands of similar instances. Referring to the supply of water, he remarked he did not think it was so bad, and that it was a mistake to burden the ratepayers with an expenditure of thirty millions when the Government, by a little pressure, might make the companies give all that was required, viz., a pure and abundant supply. It was a great anomaly, after going to the expense of obtaining and filtering the water, to use it for throwing on the roads and extinguishing fires; he thought water for these purposes might be obtained from the Thames at London-bridge and placed in reservoirs.

Dr. Wright said that all interested in this question must feel greatly obliged to the Council of the Society for calling this Congress together. He was one of those who thought they had not exactly taken the right line in investigating this question, but had rather been considering how they were to supplement and make more available existing sources, instead of taking into

consideration that large idea which was embodied in his Royal Highness' letter, namely, how they could possibly have great centres of water supply for the whole kingdom. Every river had its own natural history, like every animal, and must be looked at geologically, meteorologically, and hydrographically. Thus it would be found, on comparing the history of the Severn and the Thames, that they were very different. It would only be by taking up the individual drainage areas of the kingdom, collecting the information they already possessed, and putting it together with that deduced from further observations, that anything practical could be done. There was abundance of water in the country, but it was not utilised. Dr. Wright then procceded to propose the resolution given in the last number of the *Journal*, which was seconded by **Mr. Conder**, and, after some discussion, carried unanimously.

The Mayor of Exeter desired to thank the Society, on his part, and on the other municipalities, for the invitation given to them to attend the Congress. It was known that the water supply had in many places been taken possession of by Corporations, and they were most interested in the question, because they would for the future, in all probability have to determine on the nature of the supply and from whence to draw it. He had received a great deal of information from attending, and he was sure that many of his brethren in public municipalities had done the same.

Mr. Prestwich moved a vote of thanks to his Royal Highness the Prince of Wales, for having suggested this Congress.

Mr. W. Hawes seconded the resolution, saying they must all be pleased to see how his Royal Highness was following in the footsteps of his father, and endeavouring to arouse attention amongst the people of his country to great general principles. He could hardly have selected any one of which the result might be looked upon as of greater value than that of the best means of collecting pure water, and bringing it within the reach of all people in the country.

Mr. E. Chadwick having supported the resolution, which was carried unanimously, a vote of thanks to the Chairman, moved by **Mr. Baldwin Latham**, and seconded by **Mr. Spencer**, brought the proceedings to a close.

MEETINGS FOR THE ENSUING WEEK.

Mon.....English Cart Horse Society (at the House of the Society of Arts). 12 a.m., Council. 2 p.m., General Meeting.

Royal Institution, Albemarle-street, W., 2 p.m. General Meeting.

Society of Engineers, 6, Westminster-chambers, 7½ p.m. Mr. St. George Lane Fox, "The Lighting and Extinction of Gas by means of Electricity."

Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. H. M. Stanley, "A Geographical Sketch of the Nile and Livingstone (Congo) Basins."

British Architects, 9, Conduit-street, W., 8 p.m. General Conference of Architects. Mr. E. Armitage, "Mural Painting."

Victoria Institute, 10, Adelphi-terrace, W.C., 8 p.m. Prof. H. A. Nicholson, "Succession of Life upon our Globe."

Tues....British Architects, 9, Conduit-street, W., 11 a.m. General Conference of Architects.

Central Chamber of Agriculture (at the House of the Society of Arts), 11 a.m.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. H. Dallinger, "Minute and Low Forms of Life." (Lecture I.)

Civil Engineers, 25, Great George-street, Westminster, S.W., 9 p.m. The President's Conversazione, for Gentlemen only, India Museum, South Kensington.

Biblical Archæology, 33, Bloomsbury-street, W.C., 8½ p.m, Rev. W. Boughton, "On the Hieroglyphic or Picture Origin of the Characters of the Assyrian Syllabary."

Zoological, 11, Hanover-square, W., 8½ p.m. 1. The Secretary, "Additions to the Menagerie in May, 1878." 2. Prof. Huxley, "The Taxonomy and Distribution of Crayfishes." 3. Prof. W. H. Flower, "The Skull of a Rhinoceros from India." 4. Messrs. Godman and Salvin, "List of the Butterflies collected in Eastern New Guinea and some neighbouring Islands by Dr. Comrie during the voyage of H.M.S. *Basilisk*."

Royal Colonial, Pall-mall Restaurant, 14, Regent-street, S.W., 8 p.m. 1. Mr. Gavin Gatherall, "The Angora Goat, and its Naturalisation in British Colonies." 2. Mr. S. McBean, "A Ship Canal between India and Ceylon."

Royal Horticultural, South Kensington, S.W., 11 a.m.

Wed. ...British Architects, 9, Conduit-street. General Conference of Architects. 8 p.m., Prof. Barff, "The Corrosion of Iron."

Geological, Burlington House, W., 8 p.m. 1. Mr. C. Callaway, "On the Quartzites of Shropshire." 2. Prof. R. Owen, "The Affinities of the *Mosasauridæ*, Gervais, as exemplified in the Bony Structure of the Fore Fin." 3 Prof. H. G. Seeley, "New Species of *Procolophon* from the Cape Colony, preserved in Dr. Grierson's Museum, Thornhill, Dumfriesshire, with some remarks on the Affinities of the Genus" 4. Dr. J. W. Dawson, "The Microscopic Structure of *Stromatoporidæ*, and on Palæozoic Fossils Mineralised with Silicates, in illustration of *Eozoon*." 5. Mr. G. M. Dawson, "A New Species o *Loftusia* from British Columbia."

Entomological, 11, Chandos-street, W., 7 p.m.

Microscopical, King's College, W.C., 8 p.m.

Society for the Development of the Science of Education, United Westminster (Endowed) Schools, Alexandra-street, Victoria-street, S.W., 7.30 p.m. Mr. R. Liebreich, "School Hygiene."

Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m.

Archæological Association, 32, Sackville-street, W., 8 p.m. Mr. E. M. Thompson, "An Early Exultet Roll in the British Museum." 2. Mr. Gordon M. Hills, "The Measurements of Ptolemy and Antoninus applied to the South of England."

Obstetrical, 53, Berners-street, Oxford-street, W., 8 p.m.

Thur.....British Architects, 9, Conduit-street. General Conference of Architects. 3 p.m., Discussion on "General Building Regulations for the United Kingdom." Mr. J. Douglass Mathews, "The Model Bye-laws as a basis of a General Building Act." 8 p.m., Discussion on "Concrete and Fire-resisting Constructions."

Royal, Burlington House, W., 8½ p.m.

Antiquaries, Burlington House, W., 8½ p.m.

Linnean, Burlington House, W., 8 p.m. 1. Prof. P. Martin Duncan, "The Ophiurans of the Korean Seas. 2. Rev. R. Abbay, "Observations on *Hemileia Vastatrix* (the coffee-leaf disease)." 3. Mr. W. Percy Sladen, "The Asteroidea and Echinoidea of the Korean Seas."

Chemical Society, Burlington-house, W., 8 p.m. 1. Dr. Gladstone and Mr. Tribe, "Analogies between the Action of the Copper-Zinc Couple and Occluded and Nascent Hydrogen" 2. Dr. Wright and Mr. Luff, "The Alkaloids of the Aconites." Dr. Wright and Mr. Luff, "The Alkaloids of *Veratrum Sabadilla*." 4. Mr. J. W. Thomas, "The Action of Hydrochloric Acid on a variety of Compounds." 5 Dr. Mills and Mr. Wilson, "The Action of Oxides on Salt." 6. Messrs. A. Senier and A. Y. G. Lowe, "A New Test for Glycerine." 7. Mr. G. S. Johnson, "Ammonium Tri-iodide."

Society for the Encouragement of Fine Arts, 9, Conduit-street, W.

South London Photographic (at the House of the Society of Arts), 8 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Guthrie, "Molecular Physics." (Lecture II.)

Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.

Royal Society Club, Willis's Rooms, St. James's, S.W., 6 p.m.

Fri.......British Architects, 9, Conduit-street, W. General Conference of Architects. 3 p.m., Mr. Edward I'Anson, "The Iron Ribs to carry the Roofs of the Corn Exchange in process of re-erection in Mark-lane." 8 p.m. 1. Mr. T. Roger Smith, "Rude Stone Monuments." 2. Mr. J. S. Phené, "Troy and Mycenæ"

Royal Colonial Institute (at the House of the Society of Arts), 8 p.m.

Royal United Service Institution, Whitehall-yard, S.W., 3 p.m. Colonel G B. Matheson, "The Native States of India in Subsidiary Alliance with the British Government."

Royal Institution, Albemarle-street, W., 8 p.m., Weekly Meeting. 9 p.m , Mr. W. H. Pollock, "Romanticism."

Geologists' Association, University College, W.C., 8 p.m.

Philological, University College, W.C., 8 p.m. H.I.H. Prince Louis Lucien Bonaparte, "The Non-Italian Dialects of Modern Italy."

Archæological Institution, 16, New Burlington-street, W., 4 p.m.

Royal Botanic, Inner Circle, Regent's-park, N.W., 4 p.m. Professor Bentley, "Classification, Properties, and Uses of Plants." (Lecture V.)

Sat......Physical, The Science Schools, South Kensington, S.W., 3 p.m.

Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m

Royal Institution, Albemarle-street, W., 3 p.m. Prof. Henry Morley, "Joseph Addison."

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,333. Vol. XXVI.

FRIDAY, JUNE 7, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

CONVERSAZIONE.

The Society's *Conversazione* is fixed to take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday, the 19th June. The cards of invitation are now in course of issue.

A Vocal Concert, consisting of glees, by the London Glee and Madrigal Union, will be given from 9 to 11 o'clock, with intervals, in the Lecture Theatre.

A Promenade Concert will be given by the Band of the Coldstream Guards in the Architectural Court, and by the Band of the Royal Marines in the North Court.

The galleries containing the Raphael Cartoons, the Sheepshanks' Collection, the William Smith Collection of water-colour drawings, the Dyce and Forster Pictures, the Collections of Paintings lent by Mr. Fuller Maitland and Lord Spencer, and the Schliemann Collection of objects from Troy will be open.

The courts and corridors of the ground floors will be open. The reception will be held in the throne room of Akbar Khan in the Architectural Court, by Mr. William Hawes, F.G.S., Deputy-Chairman, and other Members of the Council.

HEALTH AND SEWAGE OF TOWNS.

This Conference met on Thursday, May the 23rd; the Right Honourable James Stansfeld, M.P., in the chair.

The Chairman, in opening the proceedings, said he had great pleasure in acceding to the request of the Council asking him to preside at its third annual Conference on the subject of the health of towns, with special reference to the question of sewage. He must commence by an apology and an excuse, for the truth was that when he accepted the invitation some two or three months ago, he had forgotten to record another engagement on the same day. He had endeavoured to make the best arrangement he could, and would have to ask the meeting to excuse him, after his opening remarks, for the rest of the morning; but he had arranged to be present in the afternoon, and the whole day to-morrow. He especially desired to be present then, because he hoped that they would get through the first six heads of discussions on that day, and deal to-morrow with the seventh, which was one of a novel and very special and important character, upon which, from his official experience, he hoped to be able to throw some light. They had seen enough of these Conferences to be satisfied with their utility, and he hoped that they would continue; but in expressing that hope, he was inclined to add that he thought the time had come when they might advisedly somewhat enlarge the programme and scope of their discussion. At present the subject was the health and sewage of towns, and that had been interpreted as meaning the health of towns as affected by sewage arrangement; but they had just had a Congress sitting for two days on the question of water supply, which was intimately connected with the question of the sewage of towns, and the health of towns, and their relations with each other. So far was that evident, that he found amongst the printed papers two which ought really to have been laid before the Congress which had just concluded its sitting, namely, those by Mr. Robinson and Dr. Bond, their subject being the Public Health Act Amendment Bill of this year, which bore on the question of water supply of small communities. He saw no reason for refusing to receive those papers, but their presence rather showed the desirability of enlarging the scope of their inquiry. He had spoken to Mr. Brown, M.P., on the subject, and requested his presence, but he was not able to be with them on that day, but had furnished him with a letter in which he gave his views, and the views of the Committee, with regard to one of the questions raised in the paper of Dr. Bond, and those views he should be able to lay before the Congress. He thought, however, they should widen the scope of these discussions to the larger question of the health of towns as affected by local government arrangements, because that seemed to be a fair subject matter for further Conferences, and would still only be a part, and, possibly, not the largest part, of a much larger question, namely, that of national health. With reference to all the causes of national health or disease, and to the influences which affected that health one way or the other, health, viewed in that large sense, might perhaps be defined as depending upon activity, moderation, and temperance, sufficiency of supply for the waste of life, and cleanliness. Activity was necessary to health, in fact, life meant activity, and there was no health which did not mean vigorous life. He need not say that a sufficiency of those supplies which were necessary for the food either of the mind or body, was a necessary part of the causes of health. Moderation and temperance were a cause of health, because all excess, of whatever kind, was against the laws of nature, and, therefore, against the laws of health. Lastly, cleanliness was a great source of health, and here it was that the functions of local government came in. What they wanted was clean air to breathe, clean water to drink, clean persons, clean habits, clean houses. Local governments could do a great deal, but not everything which had to be done in this direction. They could secure good pure water, they could bring it into every human habitation in their district; they could, although they had not yet got sufficient power, take efficient security that that sufficient supply of pure water should not be subsequently fouled or contaminated by ill-conditioned cisterns or by sewer gas. Those subjects had been discussed at the two previous annual Conferences, and they arrived at distinct conclusions, which were drawn out afterwards by the committee of the Society. They then expressed the view that, by legislation, as far as might be necessary, local authorities should have imposed on them the duty of having such control over the pipes of the house itself, as also over the drains in the street, as should enable them to fulfil their implied contract with the inhabitants of enabling them to drain the refuse of their houses away without being invaded, by way of return, by the gas created in the sewers into

which they drained. Local governments could do a great deal to prevent pollution, within the dwelling, of the air which was supplied from without; they could not in the manufacturing towns, where the air was heavily laden with smoke, or it might be with the products of chemical processes, supply the pure air of the mountain top; that was an ideal consummation to which they could hardly look forward, but taking the air as it was met with outside the house, they could take efficient precautions to secure to the inhabitants of a town this advantage at least, that that air should not be lowered in quality, and contaminated either by bad sites formed of unwholesome materials and refuse, by damp walls, by want of air space around the dwellings, or by the inflow of sewer gas. But they could not compel internal ventilation. If people preferred to shut their windows instead of keeping them open, and preferred close foul air to pure, it was impossible for a local government to have a policeman in every dwelling to see that people were wise instead of foolish in respect of the ventilation of their homes. They could not secure cleanliness of person, nor what he should call cleanliness of life and habit. All these things were matters of education, and what he desired to impress on the meeting was this, that, largely viewed, the question of health was very much a question of education, and he looked forward to the day when local government should be further advanced and better understood by the community at large; when the education of the young should be in the hands of the ordinary local government of every locality or community; for he believed it to be the true future of local government to accumulate all the functions of government in one body for one area. When that time came, he trusted the elementary truths of the science of national health would be considered as an essential part of national education, and would be taught in the schools of the community as much as the three R's. This was the third annual Conference, and the conclusions to which they came last year were these. After quoting these conclusions, the Chairman said he had already referred to a new and particularly interesting subject for discussion this year, namely, the legislative and imperial administrative question. The desirability of discussing questions of legislative improvement was raised at the last Congress by General Cotton, and towards the close of the Congress he himself suggested that the subject of further legislation might be considered this year, and went on to recommend his auditors to make themselves acquainted with the existing state of the law before beginning the discussion. He hoped that recommendation had been attended to, and that they were all conversant with the Public Health Consolidation Act, of which he had brought a copy, so that it might be referred to if necessary. Another branch of the subject was the question of a change in imperial administration, and it was especially about that that he thought it was really his duty to be present during that part of the discussion, because if he knew anything he must know something about that subject, having passed the Public Health Act, which constituted all existing sanitary authorities. He passed the Act which transformed the Poor-law Board into the Local Government Board, and was its first President, and he entertained clear and decided views as to the functions and limits of imperial supervision, and as to the method by which that imperial supervision should be brought about and administered. He should, therefore, feel bound to contribute as well as he could to the discussion, and to speak fully and frankly with all the knowledge he had acquired from his experience. He would now call upon the meeting to discuss the first question on the programme, namely, "Gradual Abolition of Cesspools and Middens, and Substitution of Tubs and Pails, with Speedy Removal."

Mr. Stansfeld then withdrew and **Sir Henry Cole** took the chair.

Sir Henry Cole said the first paper on the list was by Alderman Taylor, referring to the Rochdale system, but he believed Mr. Taylor was not present.

Mr. Schofield said he represented Rochdale, and he thought the paper should be read, or else it could not be properly discussed.

The Chairman said Mr. Schofield had better state the substance of the paper.

Mr Schofield said they had now been for some years past carrying out the pail system in Rochdale, and from Alderman Taylor's paper it would be seen how rapidly the system had been growing, so that there were now 7,504 closets adapted to the new system. There were about 14,000 houses in the town, and more than half were on the new system. This had been done entirely without resort to compulsion of any kind until within the last two months, and they had only done that because having here and there a house on the old system in particular streets greatly increased the cost of collection, when carts had to go from one street to another. For that reason they had required the inhabitants of particular districts to adapt the whole of their closets to the new system. The great difficulty from the beginning had been the manufacture of the excreta into manure, which would be saleable, so as not to involve too great a cost to the town. At first the manure made was of low value, and would not bear the cost of transit. Their object had been for a long time to effect some mode of drying so as to greatly reduce the bulk and improve the quality. It would be seen by reference to the printed table that they had now two machines which reduce 14 tons of material collected to 1 ton 3 cwt., there being added 25 lbs. of sulphuric acid to each ton. Then followed the detailed analysis of the dry product, a specimen of which might be seen in the adjoining room. It very much resembled good guano, and was worth £6 or £7 a ton. The fact that they had been able to reduce the bulk and weight to so large an extent as to produce a manure of great value were the facts to which he wished to call the special attention of the Congress.

Mr. Edwin Chadwick, C.B., asked what the cost was and how often the stuff was removed?

Mr. Schofield said weekly.

Mr. Haresceugh said the cost of removal was about £1 per house per annum.

Mr. Green asked what was done with the domestic slops and storm waters, and what was the cost of disposing of them?

Mr. Schofield said they did not deal with the water question at all, but simply the excreta from the closets, and the ashes. In reply to Mr. Chadwick, he added that there was a distinct system of sewers to carry away the house slops. This at present went into the river; they were making arrangements to take it out, but had not yet succeeded.

Colonel Jones asked the price per ton at which this was sold, and whether it was sold under a guaranteed analysis?

Mr. Haresceugh said it was selling at present at £6 10s. per ton. They had far more orders than they could supply. The guaranteed analysis was from 9 to 10 per cent. of ammonia, 6 to 7 per cent. of phosphate of lime, and about 12 per cent. of alkaline salts. For a long time they had been trying to bring out a manure which would not only sell well, but would enable them to get rid of the stuff being sent off in a crude state, mixed with ashes, but by that method they had to take it away into Cheshire, and dispose of it at 3s. a ton; consequently it was a losing game, because they had 2s. 4d. to pay for carriage, besides the expense of carting it to the station; therefore it was a great loss. They had now got two machines at work, he did not say

they were perfect, but he believed they would make them so. At present they would work about 14 tons per day, but when they got more steam power they would be able to do much more. To get rid of 10 tons of the excreta in a crude state they would require to mix it with 14 tons of ashes, so that they would have to send away 24 tons a day in the way of crude excreta, which would cost them at least 2s. a ton to get rid of, besides what they received for the manure, but 10 tons of that stuff did not yield under the improved process more than about 16 cwt. of finished manure, which was worth 6s. 6d. per cwt., and the amount of labour required was much less than that required in the crude state, therefore there was a saving of labour, and the manure was worth something when it was done. There had also been a great difficulty in getting rid of the great quantity of crude material from the old ashpits; in fact they had to beg people to accept of it. They had now about 1,200 of these old closets, which they were rapidly doing away with. Another important point was this, that they could do it all in a cleanly way. Their manufactory was as free from smell as that room. When they had the stuff piled up in great heaps it was unsightly and offensive but now the place was whitewashed and kept clean and sweet. In fact, he could prepare the stuff next door to anyone's house, and he would not know it was there.

Mr. J. M. Fox said the essential principle of his paper was that excreta should be dealt with at once and by the individual. He was glad of the interesting discussion on the Rochdale system, because it gave him an opportunity to pay a tribute of praise to Rochdale for having been the pioneer with reference to the pail system and dry method. At the same time he wished to say, in the most unqualified manner, that Rochdale, as a large town, had made a most complete mistake, and the same with Manchester and Halifax, in adopting the dry system. He gave Rochdale credit for having made experiments in this matter, which had been useful to rural districts and small villages and hamlets, but he thought it was quite a mistake for any large town, with sewers and water supply, to be satisfied with the dry method. He was much struck with a remark made by the Premier, in his speech at the Royal Academy dinner, that civilisation was essentially comfortable. Now, the dry method, he contended, was essentially uncomfortable for a town. The water-closet was the only comfortable method with which at present English civilisation would be satisfied. Yesterday we had dealt with the purity of water, and the Chairman had dealt with the purity of air. Now, excrement was the worst source of pollution of both, and the most injurious kind was human excrement. He contended, therefore, that we must not be timid in grappling with the very beginning of this matter, and the beginning was with individual convictions. It was very easy to talk about dealing with excreta on a large scale, but it did not sound so well to talk about individual action and duty in this matter. People are not at all afraid of talking about engineering arrangements for big towns, but anything like a personal responsibility is lost sight of. His experience had been very much in rural districts, although he had had the management in point of health of sewered towns. The greater part of his work had been in small villages where there were no sewers and no water supply, and where, therefore, the water carriage method could not be obtained. The first thing was to do something. He was told, when he went into Cumberland, that the colliers did not want privies, but he suggested that even colliers had wives and daughters, and that they should not be relegated to the same rural practice as the men. Thus, by degrees, he got boards of guardians and colliery owners to see that a different arrangement must be made from that which had prevailed. The principle of his paper was one suggested by the consideration of the practice imposed upon a nation still in existence, whose first legislator had universal credit as having been the prince amongst legislators, and Moses was not timid in this matter. He did not content himself simply with laws appertaining to national defence, with art, or religion, or commerce, but he dealt with this matter by making a sanitary regulation which was binding on the individual. He had been glad to listen to the remarks of the former President of the Local Government Board on the subject of education, who considered that there must be a great deal of education in connection with subjects bearing on the public health. If this idea of individual obligation had been put before the people they might have been more advanced in education in this respect. He should like every person to feel that, if he deposited a nuisance anywhere, and left it to pollute the air, he did a wrong, and made no attempt at reparation for it. Now, with the water-closet system you did make a reparation. When the nuisance was committed, the handle was lifted up and it was removed. He was quite prepared to admit that they had not yet, in practice, got the sewers into a perfect condition, or a complete provision against sewer gas; but it must be remembered that the defects in carrying out a system still in its infancy were no argument against the principle. When a man used a closet he made reparation in the way he had spoken of. In the dry method he contended that something similar should be done. The requirement he had made at Cockermouth was, therefore, that ashes should be sifted on the *dejecta* each day. If Rochdale or any other town could not make its sewage pay without keeping it just as it was in a crude state, he said that system was a nuisance and an abomination, and the commercial principle, which was carefully excluded from the discussion with regard to the supply of water, must not enter into this question at all. The very temptation which existed with a dry method, to look at the commercial aspect of the question and give a good balance-sheet, and the utter impossibility of doing so by a sensible mode of procedure, was an argument against the adoption of that method on a large scale. The natural mode of dealing with excreta was either to remove it and get it away, or to deal with it in the way of disinfection. Let it be covered up with earth or ashes, but it must be done at once, and must not be left a week to pollute the curtilage, because, unless it was undealt with, it would not sell. He would not say that dry earth was absolutely necessary, for ashes would do, as they absorbed the urine and prevented very much of the putrefactive fermentation. The paper had not only touched upon this principle, but also dealt with an addition to the law in conformity with the view expressed therein. He thought it should be defined in the statute clearly when a privy was a nuisance and when it was not. A privy was a nuisance when the excreta was uncovered. As the law stood at present it was difficult to decide whether a privy was a nuisance or not, or to say what was the maximum smell beyond which it became a nuisance. It depended very much on the olfactory organs of the inspector, but he thought we should get out of the region of opinion and into the region of fact; therefore he had made the suggestion to be found at the close of his paper. The remarks of the Chairman brought to his mind the arrangements in schools, and he thought it was very important that children should be taught what is right in these matters; and that hygienic observances should not be lost sight of in determining the character of a school.

Dr. Wilson (Rochdale) wished to make a remark on the rather exaggerated statements of the last speaker. He said the authorities in Rochdale had made a fatal mistake in adopting the dry system. Granting that were so, it was a mistake which they made in common with some of the largest and most important cities in England, such as Manchester, Birmingham, Sheffield, and Leicester, and he thought it was only true to say that tho authorities of those towns, when they first

considered this question, had the primary interest of the inhabitants at heart, and that it was not a mere question of pounds, shillings, and pence with them. But there was another point with regard to Rochdale. If they, when the question of how best to deal with the change from the old middens was first discussed, had adopted the water-closet system, where were they to get the water from? In 1867 they were in this position, that water-carts had to be sent through the streets, and water was obtained from temporary sources to supply the ordinary wants of the inhabitants. With regard to this system being a nuisance and abomination, and so on, he thought the best answer would be to ask what were the results on the health of the inhabitants, and the sanitary condition of the town; and it was a singular coincidence that ever since this system was introduced, in 1870, there had been a continuous lessening of the death-rate. They dealt with the excreta on the principle mentioned in Mr. Taylor's paper, viz., that it was not to be allowed to become offensive to the people, neither when deposited nor in its collection. They did not manufacture it into manure as a commercial speculation, but because they could not otherwise get rid of it. He could thoroughly bear out the statement they had heard that morning, as to the mode in which it was dealt with, that there was no nuisance at the works, and it so happened that this method of dealing with it also produced a valuable product, but that was not the essential thing with the authorities. The death-rate was formerly very high, 27 per 1,000. In the first three years after the introduction of this system, it fell to 24, in the sixth year to 22, and last year it was under 21 per 1,000. For a large manufacturing town, having about 71,000 inhabitants, that was a good test, and it was creditable to the authorities to have done so much. He could speak with the more freedom on this point because the greater part of this reform was carried out before he went to Rochdale as medical officer of health there. It must also be remembered that, dealing with the excreta was only part of the Rochdale system. They also dealt with the dry refuse—that from slaughterhouses, fishmongers, and so on, which the best water-closet system must still leave untouched.

Mr. Williams (Liverpool) said there were five systems at present of getting rid of excreta. Mr. Fox's favourite appeared to be the Mosaic, but he did not think that was likely to make any progress at present. The second was the pail system, and that was, to his mind, so disgusting as to make it almost difficult to write the word. The third was the earth-closet, which was an improvement, but that again would have to go into the hospital; it could not survive. The fourth was the water-closet and water-carriage system, and that was the best of the four, to his mind. But that again would have to go into limbo. The previous day he had had an opportunity of making a few remarks on sewage and sewer gas, and how readily that gas found its way into houses, and therefore the fifth system, the Liernur system, he considered the best.

Dr. Fox said he had been slightly misunderstood. He merely referred to Moses as laying down a principle, and did not advocate the carrying out of the exact plan he had described. He should be sorry for any gentleman from Rochdale to think that he suggested that, because cost was the first element of consideration. No doubt it was for the protection of the public health, but he felt that cost was so mixed up with the way in which they had to carry it out, that it hampered them very much. As to the improvement in Rochdale, he was perfectly certain that if any town would abolish its old filthy privies, and adopt any system whatever, there must be an improvement in the health.

The Chairman drew attention to the description amongst the printed papers of the Chinese system, and added that until the last 150 years human excrement had gone on to the land as best it could in England. The report of the Rivers Pollution Commission stated that men ought to be the best farming stock we had; that the excrement of a sheep was worth at least 5s. a year to a farmer, and that of man ought to be far more valuable. They must all admit that unless fertilising properties were put back on to the land it would cease to produce anything at all. Of course they had a great importation of guano, and throughout the whole of Europe everybody was struggling to get the stuff into the land somehow. The sheep was a very valuable creature for this purpose, and was very ready to put the manure where it was wanted; but a man, who ought to be the most profitable of animals for the land, was only worth in Lancashire and Yorkshire about 5d. a year, and it was very difficult even to get that. The agricultural worthlessness of the enormous stock of man in the Mersey valley, as folded on the land, was a perfect scandal. Rochdale was an instance where they were trying to utilise it and be clean, and he hoped they were going to succeed. As regards their being clean, he must say something in answer to what had been said from his own experience. He had been to Rochdale once or twice, and had visited some of the dirtiest quarters of the town, inhabited chiefly by Irish. He examined the closets there, there being one between every two houses, and he found them very much sweeter than some water-closets, and an immense deal sweeter than a privy in a garden. An old woman came out; and a friend who accompanied him, remarked to her, how sweet and clean the place was, when she said "Clane! your honour! we have all become clane since we got rid o' those bastely English." The Chinese, although they were very dirty, and did not manage the work very well, had for hundreds of years known how to deal with this question. He had a quotation from Hakluyt, who wrote a book on the principal navigations and discoveries of the English nation in the year 1589, and in his second volume, speaking of China, he described a class of persons who went about in every street buying this dirty ware, and said "The custom is very good for keeping the city clean." He entirely differed with Dr. Fox in thinking that water-closets were the right thing. Water was the most profligate associate of excreta. The excrement and urine were valuable, and the problem to be solved was how to turn them into the land with the greatest profit. He had been looking closely into this question for some years, and he ventured to say that in eight months from this time they would find another large town—Blackburn—which was adopting means to prove that they could deal with this excrement as quickly as possible without nuisance. According to Dr. Voelcker, Blackburn would produce a manure containing about half as much as Peruvian guano.

Mr. Spencer said he would ask gentlemen to use their common sense. Could they suppose it possible that the Maker of All had made any animal so that its own excrement should be poisonous? The fact was, the excrement of no animal was poisonous, but when it came in contact with water, decomposition took place, and it was unwholesome. From fresh excreta there was a certain amount of sulphuretted hydrogen given off, which was unpleasant; but when they went to Harrogate to drink the water, they smelt 50 times as much sulphuretted hydrogen, and considered it wholesome.

Mr. Chesshire then stated the substance of his paper, and said his object was not to advocate his own particular plan, nor any other, but to advocate the principle of interception. He also wished particularly to say that the term "sewage," as applied to excreta, was a misnomer, and tended very materially to mystify the whole discussion. Human beings did not void sewage. The sewage was the contents of the sewer, of whatever material these contents might

be composed, and the excreta of the population was quite different from sewage; in fact it would be as correct to speak of the sewage from heaven as to speak of the sewage of individuals, for a much larger proportion of the contents of town sewers consisted of rain water than of what came from the inhabitants.

The Chairman asked if Mr. Chesshire's plan had been adopted anywhere?

Mr. Chesshire said it had been in numbers of instances, in India, Norway, and in several places in England.

The Chairman said no doubt Mr. Chesshire was quite right scientifically, but he feared it was like other panaceas, not practical.

Mr. Chesshire said his plan was most practical, though it had not been used as a system anywhere, but only in isolated cases.

Mr. Chadwick asked what was the cost?

Mr. Chesshire replied, probably about 2 guineas, or it might be 3.

Mr. Williams said the urine was the most valuable part of excreta, and he understood that was thrown away.

Mr. Chesshire said no, it was treated at the outfall.

Mr. Edwin Chadwick, C.B., said—It is due to the Congress to state my views on the relative sanitary and economical merits of the principles of water-carriage, as compared with the pail system of the removal of the excreta, as brought forward by the representatives from Rochdale. The primary condition to be dealt with on sanitary principles is this, that the removal of all fæcal matter from within or beneath houses, or the sites of towns, shall be effected before putrefactive decomposition commences. We ascertained that, in ordinary weather, commencement of the putrefaction of such matter in solution in water is within about four days. In some conditions it is immediate, and in some weathers it is within the day. Prolonged exposure to the emanations of putrefaction, even in ordinary weather, tells upon the strong, and eventually it leaves its mark upon the death-rates, but short exposure particularly affects the diseased, the weakly, and the susceptible, especially in epidemic periods. During epidemic periods we gave orders at the General Board of Health for the removal daily of all putrescible matter from within or without urban dwellings. Now, how long would a physician or a careful nurse allow such matter to be kept in a pail and undiluted, in a sick chamber or within the premises? In the lower district of badly administered towns, in this respect, such as Manchester and Birmingham, excreta were allowed to remain in cess-pits and middensteads, in heaps in state of putrifactive decomposition for a year. It is, doubtless, an important mitigation of such insanitary conditions to reduce the period of the exposition of putrescent matter, and to remove it within a week; but that is more than three days too late, even in ordinary weathers. It is three days of developed putrefaction and of the noxious gases. Now, is there any officer of health here who understands his duties, who can be unaware that the thousands of such sources of pollution of the atmosphere in Manchester proper, upwards of a hundred thousand, or of Birmingham, will not sensibly affect the sickness and death-rates of an urban population. But the representatives of Rochdale say that a reduction of the death-rate has followed the introduction of the pail system, and they present it boastfully as a final accomplishment. From what I have stated, it would follow that their removal should effect some reduction of the death-rate, it being clearly a reduction of the evil. But the removal by water-carriage is not in the week or in the day, or even in the hour, but in the minute, and in connection with properly constructed channels, it is a complete removal, followed, and it is followed with certainty, by a more full reduction of the death-rate. The representatives from Rochdale have congratulated themselves upon what they consider to be a high state of health, as denoted by what they consider a low death-rate of 20 in the thousand. But they have yet to learn what good attainable standards of health are. I give them an approach to one. Dover had, when first dealt with by the first General Board of Health, about the same death-rate or a little higher, and has now what Rochdale might have now under competent sanitary rule, a death-rate of fourteen per thousand. The difference between well water-closeted urban districts and "tubbed" or middenstead districts, is generally a difference of one-third in the death-rate. On observation I venture to assert, that the present defective sanitary rule at Rochdale involves a loss of at least eighty lives annually of that very good population, besides more than twenty times that number of preventible cases of sickness, involving extensive premature working disability. On the other side, however, we have heard here carriage by water denounced as a means of the distribution of poisonous gases through houses and towns. It is to be made known to those who give such descriptions, that what they call carriage by water is, through want of competent administration and of skill, to be correctly called "mis-carriage by water." Under the insanitary administration and ignorance of systematic works, not only by common builders, but by architects, and even by insanitary engineers, as we have shown even here under the government of the metropolis, the works for water-carriage are extensively so misconstructed as to miscarry, and to detain, in conditions of putrefaction, what ought to be removed, under which conditions they are no better than the pail system. The common flap traps of the water-closet are frequently so constructed as to throw aside and keep much of the fæcal matter under the seat. The common channels for water-carriage, the house drains, are frequently constructed of permeable brick, or of large tubular pot drains, so constructed, and so laid, as to obstruct the flow, to occasion deposit, or to let the liquefied excrementary matter out at the sides, or at the joints, and create excrement-sodden subsoils. And next, the sewers into which the surplus contents of the house drains discharged are so constructed, of such large sizes, and forms, and inclinations, as to obstruct the flow, and to detain matter in conditions of noxious decomposition, and generate foul gases, which are discharged into the streets and houses, until the matter is flushed out artificially, or by extraordinary storms at long intervals, when that removal takes place, which, with proper constructions for water carriage, should be instant and constant. Such are the conditions of ignorant, unskilful water miscarriage, misdirection, and consequent stagnation, almost general with the house drainage of the metropolis, and to the extent of a thousand miles of sewage of deposit. And such conditions of expensive and unskilful miscarriage are called "water carriage;" and I, who have directed trial works and elaborated complete instructions for preventing these noxious conditions have been here denounced for creating them! Ill-constructed, in the defiance of sanitary science, the water-closet is a source of disease; well constructed, it is a great means of prevention. Of this I can give conclusive proofs. Here is one. The well-kept prison is, as I have shown elsewhere, the highest norma of health in the country; the general death-rate amongst those not brought there in a state of disease, being not more than three in a thousand. In every cell of the model prisons there has been a soil-pan. I do not regard it as a source of health; it is simply a channel for the immediate removal of the putrescent matter which is the cause of disease. This arrangement is now, I understand, being altered in prisons, not on account

of any sanitary objection, but because it was found that the prisoners used the soil-pan as a sort of speaking trumpet to communicate with the other prisoners. Now, as to the relative expense of the two systems, the dry carriage and the water carriage. We have heard it stated, that the cost at Rochdale of the weekly removal by the tub is £1 per house per annum. This is about four times more than the system of immediate removal by water carriage, in connection with the necessary removal of the kitchen and laundry slops by the house drains which must be provided for that liquefied manure. The augmentation of the expense by a half-weekly or a daily removal of the putrescent matter and the augmented annoyance of the process, is a barrier to the improvement of the tub system by a more frequent, or a daily removal requisite to make it safer. Human fæces are treated as if they constituted the great bulk of the putrescible, manurial matter to be removed from a house, whereas they constitute a very minor part of it. The Rivers Pollution Commissioners found that between a water-closeted and a non-water-closeted town, the difference in the manurial matter at the outfall of the sewers was about one-fifth. The cost of the weekly removal by the tub of that one-fifth will everywhere be found to be much greater than the cost of the most complete system of instant removal by self-cleansing sewers in which there is no stagnation and from whence there is no smell. Wherever there is the escape of smell there is bad engineering, bad work, bad supervision, wasteful and bad administration. The construction of large sewers, to receive extraordinary quantities of storm-water, occasioning deposit during the ordinary flow, and also deteriorating the sewage as manure for the farmer by excessive and irregular dilution, is all a forewarned big blunder by the local authorities. Effort is now being given to the protection of houses, by trapping, against the admission of sewer gases; that should be given by correct construction of the drains and sewers, against the generation of those gases from stagnation. One argument in support of the dry system of carriage, as at Rochdale, as to its conservancy as manure (which is at the expense of the health of the population by its detention amidst houses), is erroneous, as the system is wasteful of manure, which is best conserved by its immediate reception in water, and by its immediate removal to the land. In water-closeted towns, such as Croydon, Leamington, and Bedford, the whole of the manure from the houses is on the land in two or three hours; and, on the same system of water-carriage, the whole of the manure of the metropolis might be on the land, not in mechanical suspension, but in chemical combination, within the day. The dry system for agriculture is wasteful of labour and manure, and in contravention of the maxim laid down by the greatest vegetable physiologist of the last century, De Candolle, that the future of agriculture will be in giving water and food to the plant, manure, at the same time. Plants do not feed on dry manure, for which they have no mouths, but assimilate liquefied manure or gaseous moisture. The processes for solidifying manure are generally processes for taking manure out of water to be put in water again for assimilation, as by the liquid manure drills. The argument in support of dry-carriage, that land is not to be had for water-carriage, will be required to be met by better legislation, which will reduce unearned monopoly value of quadruple and quinquennial rentals. A right of expropriation, at double the average rental of the land, with which landowners should be content, would generally suffice for the relief of urban populations, and should in that respect be contended for. No material inconvenience is found at sewage farms in dealing with the sludge or solid deposit, removed by water-carriage. It usually occupies a small per-centage, three or four, of the land in which it is worked in like the solid manures in market-garden culture, but that manipulation is expensive; and I consider that that portion of water-carried matter admits in some cases, where there is a large amount of it, of such improvement as General Scott has made. Nature abhors stagnation, whether dry or wet, and punishes people for it. The arterial and venous system of constant circulation is, however, with the progress of science, making way against it.

The Chairman next called upon Mr. Pollard, of Halifax.

Mr. J. Pollard (Halifax) said, in making a few remarks on the Goux system, as adopted at Halifax, I think I may do so briefly by comparing the cost, as given by me at the Conference last May, for the year 1876, with the year 1877. The total cost of cleansing 3,400 closet tubs and ashes tubs, in 1876, amounted to £3,666 2s. 2d., and the receipts for manure sold, £500, leaving a nett cost of £3,166 2s. 2d., being at the rate of 18s. 7d. per closet per annum; whilst, during 1877, we had 3,800 closets, being an increase of 400 over 1876, and the cost of collection amounted to £3,678 14s. 6d., and the receipts for manure sold, £516 13s. 6d., and an average cost of 16s. 8d. per closet; thus showing, as I stated last year, that the same staff of men and horses could clear more closets at a less cost, as the area is no greater for 3,800 than it was for 3,400. At present the cost of working the Goux department is paid as follows:—The owner or occupier pays 5s. per closet per annum, and the remainder is paid out of the rates; and, I think, next year the sanitary committee will recommend that the whole cost of cleansing both Goux closets, and old privies, and ash-pits, should be paid out of rates, as it will then save the cost of collecting the charges for Goux closets and ash-pits. As a deodoriser for the tubs lining and manure, we still use charcoal and soot, which gradually but constantly deodorises the contents as the tub becomes filled. We frequently have to compare charcoal with newly invented deodorisers, and as yet we have found nothing which, in our opinion, surpasses it. The value of charcoal may be easily tested by putting a handful into a tub of excreta, and in a few minutes the smell is almost entirely gone. We are now making two qualities of manure; one is made by mixing screened ashes, street sweepings, shoddy (costing 7s. per ton), soot, and excreta, which is sold at 2s. 6d. per ton; and a better quality of manure is made by mixing together shoddy, charcoal, and excreta, which sells at 8s. per ton; one ton of this shoddy takes up about four or five tons of excreta to make it portable, and after being deposited a few days in our sheds for the liquid matter to drain off, it is carted away by neighbouring farmers, or sent away by canal into farming districts; a little over 25 per cent. of the tub contents brought into the depôt is drained off into a large covered tank, and is sold at 1s. per barrel. The shoddy used for this manure costs 20s. per ton. Part of it consists, I believe, of ground rags with the cotton fibre burnt out of it with sulphuric acid; but it is chiefly woollen dust, and is mostly sent into Kent and other districts for growing hops. So far, we have had a good demand for both kinds of manure; in fact, we have not been able to supply the demand. Respecting the question as to the emptying of ash-pits under the old privy system at Halifax, I may say that it has been as follows:—

1	ash-pit was emptied	5	times
8	,, ,,	4	,,
34	,, ,,	3	,,
162	,, ,,	2	,,
970	,, ,,	once.	

So that five-sixths are emptied only once a year. The cost paid to a contractor for emptying ash-pits is 14s. each ash-pit, so that the cost of clearing the Goux closet once every eight to ten days is only 2s. 8d. more per

closet than the old privy, which is emptied once, and in some cases two or three times a year, but if the old ash-pit was to be emptied more than once a year then the Goux system is considerably cheaper, and looking at the old method in a sanitary point, where the contents, all kinds of vegetable and animal matter, putrify in the sun, or percolate under our dwellings, endangering the lives of thousands in our large towns. I saw the other day a large ash-pit with 10 privies emptying into it, and it was situate between and adjoining 20 cottages. There was a bedroom over, and the ash-pit was on a level with the cottage cellars, and there is no doubt that a portion of the contents percolate under the houses, and perhaps the very foundations are saturated with liquid matter from those privies. The death-rate before we had the Goux system was in 1870, 29·0; and in 1871, 31·5; whilst in 1876 it was 23·5; and 1877, 25·8 per 1,000; and what will, perhaps, be more striking, is the rate of mortality during last year in Halifax from zymotic diseases where the Goux closets existed as compared with water-closets and privies.

Number of Goux closets	3,800	Deaths	29
,, water-closets	2,659	,,	36
,, old privies..	3,063	,,	41

So that it will be observed that the death-rate is very seriously in excess where water-closets and privies are in use; but I think I must leave the figures to speak for themselves. It may be observed that there is only an increase of 400 to the Goux system during 1877, but that no doubt arises from the depression in the building trade, together with the small owners of cottage property not being in a position to alter them, and not from any fear of the system being a success, as it is a rare occurrence where we have complaints; and I believe the Goux system is the greatest boon that was ever given to the poor and overcrowded districts in Halifax. The following table shows the analysis of the dust manure or "shoddy," as tested by Agricultural and Horticultural Associations' analyst, January, 1878:—

Moisture	10·54
Organic matter	65·06*
Phosphates	1·76
Alumina, carbonate of ammonia, phosphate, &c.	5·24
Insoluble matter	17·40
	100·00

Mr. Green asked if the urine and liquid slops did not still go to pollute the river?

Mr. Pollard said the urine was taken away with the closet tub, and drained off into a tank, and was sold in barrels to farmers. The whole of the slops went into the sewers, and was discharged into settling and filtering tanks.

Mr. Robert McNicoll, medical officer of health for St. Helen's, said that if towns which had not yet introduced any new system required any justification for their delay, it would be found in the contradictory opinions expressed by different gentlemen on that and other occasions. It was very good, no doubt, on the part of Rochdale and other towns to go to the serious expense of trying experiments, and it would not do for everyone to wait for other people; but those who had waited must not be understood to be doing so entirely from apathy, but because they wanted to know in what direction they ought to travel. When parties were somewhat agreed as to what was the best and the second best mode of dealing with this question, they should be ready to adopt it. He quite agreed that they must be first pure, and then economical, and, therefore, the commercial element should not be paid too much attention to. In St. Helen's they had carried out the old midden system, and tried to do it efficiently and quickly, and although the death-rate for special reasons, it being a chemical town, was still high, it was only 21 last year, 22 the year before, and 23 the year previously. This was not very bad for a town polluted with noxious vapours.

* Containing nitrogen 2·77, equal to ammonia 3·36.

Mr. S. Alcock (Sunderland) said in his town they were, probably, better situated for carrying out the water-carriage system than almost any other town in the kingdom. They had found, as he fancied all large towns would find, that it was impossible to take one system and carry it out throughout without reference to circumstances. Supposing they were of opinion, which they were not altogether, that the water-closet was the best system, how were they to enforce it? The Act did not empower any local authority to say that a person should remove an efficient privy and provide water-closet accommodation; and if a man had an efficient privy it gave them no power to get rid of it. They might agree that it would be desirable to get rid not only of cesspools, but also of privies and ash-pits, but they found they were in a difficulty in doing it, and had no power to enforce such a measure. Therefore, they were obliged to turn their attention in Sunderland to the adoption of some system besides the water-closets. They visited various places, Rochdale amongst others, and were very much indebted to Rochdale for commencing a system of that kind, and showing how the thing could be done very satisfactorily indeed. They had come to the conclusion that the pail or tub system was most desirable in connection also, where it could be done, with the water-closet. In some of the more crowded parts of Sunderland the adoption of water-closets had been enforced, but they had been obliged to remove them, for in many places where large numbers of people occupied the same house, they did not seem to have the slightest respect for sanitary laws, and the water-closet did not act satisfactorily. Mr. Chadwick had spoken of removal once a week, but that was not a necessary part of the tub system. It might be removed daily, if necessary, and in all large towns they were obliged to have, more or less, a system of daily removal of some kind, to get rid of the rubbish, and that could not be avoided by the most perfect system of water-closets. Another great advantage was that you could isolate cases of infectious disease. Again, when the excrement was thrown into the sewers, it was to a considerable extent wasted, and when it ran into the sea, entirely so.

Mr. Chadwick asked if they had no land near Sunderland available for irrigation?

Mr. S. Alcock said it was enough to frighten any town which thought of adopting a system of utilisation of sewage, to go to Birmingham and Manchester, and see the immense expenditure necessary for a sewage farm.

Mr. Turner (Portsmouth) said in discussing this question of the tubs over water-closets, it seemed to be held that it was a mistake to put the excrement into water, and that, if mixed with ashes, decomposition was to a great extent prevented. In all the towns in which the pail system was being carried out, ashes, as a rule, had not been used, and the excrement had been allowed to remain in pails for a longer or shorter time. It was claimed that by this method you had a means of isolating cases of infection, although there seemed to be no treatment of the liquid portion, which was just as dangerous to public health as diseased excrement. Then, again, he would remark that healthy people must use the same closet, for a certain time, until the disease was discovered, and they would be exposed to direct infection. Again, it was said that decomposition did not set in early, but in cases of disease it had very often commenced already in the bowels. Any person who had examined freshly-passed fæces, knew that in a healthy individual there was very little sign of decomposition; but directly the bowels became disordered you

had all sorts of organisms springing up and showing themselves immediately the excrement was passed. With reference to sewage gas, and the fact of wealthy people being affected rather than poor persons, he was aware that it had been observed on several occasions, but it was not because people had water-closets that they had disease, but because they wilfully misconstructed those places. Out of 100 closets in London very likely 99 were not properly constructed. You must not suppose that all the evils of a bad system were necessarily connected with water-closets. You might have a water-closet so good and so properly arranged that you could not by any possible means derive any ill effect from it. Still he thought Mr. Chadwick had made an unfair use of prison statistics in quoting the death-rate at 3 per 1,000, because one must recollect the ages of the people you had there; they were all at the healthiest periods of life; there were no children; the inhabitants were forcibly placed under good conditions; not allowed more food than was absolutely necessary to keep them alive; and, in all these things combined you could hardly help having a healthy set of men.

Dr. Yeld (of Sunderland) said he should like to supplement the remarks of the Deputy Town Clerk of Sunderland, especially in reference to what had been said by the Chairman as to the disposal of the excrement of large towns. Mr. Chadwick seemed to have the water-closet theory a good deal on his mind, and to forget altogether the great agricultural districts of England, over large districts of which it was impossible the water-carriage method could be applied. In large towns the greatest difficulty was the disposal of refuse when it was collected, and that arose not from want of purchasers, but from want of facility to get it conveyed to the agricultural districts. In their own town last year there were something like 30,000 tons of refuse, of which 23,000 went on to the land in the neighbourhood, and there was no one but would admit it was far better that it should do so than go into sewers and out to sea. It must also be remembered that although sewage carried on to land would do an immense amount of good, there was certain land which it would not percolate, and where, if applied, it would be utterly useless, whereas if the excreta, mixed with ashes, were put on the land, there were hundreds and thousands of acres of heavy clay-land which would be immensely improved.

Mr. Hawkins (Wallingford) said it seemed to him that they should have two systems, and he wished to ask whether by the pail system the liquid slops were mixed with the excreta?

The Chairman said no, the introduction of slops into the pails was prohibited.

Mr. Hawkins said whenever the dry-earth or pail system was adopted, it seemed to be understood that there must be a separate system of house slops, and then came the question whether it was worth while having the expense of two systems.

The Chairman said there must be a system of drainage in any case, for carrying off the surface water.

Mr. Kerr (Halifax) had had personal experience of the pail system, and as far as his observation went, it was the best. He believed the Goux was the best system of collection, though they had given away the manure. If they could adopt the system in operation in Birmingham, namely, that of General Scott, he thought that would be the best for making the most of it.

Mr. Leech said he represented a district near Manchester, and they found that closets were often a great nuisance. If rich people could not keep them in order, as often happened, he did not know how the poor were to do it, He knew a district where they had just laid down a system of drainage, and spent some thousands of pounds, but it did not prevent an intolerable smell coming up directly the river rose at all; and there was no question that they would have to do something to prevent it. They had been looking at the pail system, and liked it very well, but found a difficulty in carrying it out, because the pails became offensive. People would not pour ashes into the pails, or take proper care. He happened lately to go into Cumberland, where they were in a very primitive state, and had no such things as closets, but had a tub filled with ashes with a board over it. A friend of his seeing this plan thought he could improve upon it, and had invented a kind of handle with a rotary motion, so that every time the closet was used it spread the ashes over it; and, he believed, if something of that kind could be made it would be the best thing for many districts.

The Congress then adjourned for luncheon.

On resuming, **Mr. Stansfeld** again took the chair, and said he hoped they would endeavour to get through the remaining five heads of discussion, so as to leave only the seventh for the following day.

Mr. George Hurst then stated the effect of his paper.

Mr. Chadwick asked what was the number of houses in Bedford?

Mr. Hurst said the population was about 19,000, and the houses were water-closeted. They heard of no complaints of anything offensive in any way whatever. In every town there would be filthy people who would not keep their own persons nor anything about them clean, but, taking it as a whole, nothing offensive had ever occurred.

Mr. Haresceugh asked what was done with the vegetable refuse and ashes?

Mr. Hurst said they were carted away for gardens and farms. Those matters were not offensive to health.

Mr. Chesshire asked what was the condition of the house drains?

Mr. Hurst said his own drains had nothing offensive about them, and he had heard of no complaints.

Mr. Haresceugh asked if the farmers bought the ashes and refuse for the purpose of manuring their farms, or if they were fond of having cinders to manure with?

Mr. Hurst said there were people who made a trade of collecting dust and ashes and carting it away.

Mr. C. N. Cresswell said his paper had a double aspect, but he would confine his remarks at present to the second head of the discussion, namely, what progress, if any, had been made in treating water-carried sewage during last year? He considered the most important words in that query were the words "if any." He much regretted that the magnificent map which hung on the wall during the discussion on water supply had been removed, for it would have been the most eloquent advocate he could desire of the proposition he put forward, which was that they had made no progress whatever. That map purported to be a cartoon of the polluted rivers of England, each river being marked by a deep blue line, and each watershed was marked so as to show the source of pollution, and its character and extent. If the Rivers Pollution Commission had never done anything else to earn the gratitude of the country, the production of that map was enough. the words "Polluted Rivers" must have been put on it in irony, because every river was polluted, from the Tay, in Scotland, down to the Dart. It was accompanied by another map, which showed the extent of pollution by a deep blue mark, and there were only five small white spots over the face of the whole country, one at the extreme end of Cornwall, another in Wales, another at the extreme end of Kent, and again at the

north of Scotland. From that they might form some notion of the amount of pollution going on, which rendered it impossible that this meeting could say, with any consciousness of truth, that they had made any progress whatever in dealing with water-carried sewage. They were in this position, that at the present moment they had not so much power of dealing with the accumulated sewage as they had 20 years ago. And why? That want of progress was due to two causes, to which he would call attention. The first, and probably the most important of the two, was the same which had hindered progress in another place, of which they had heard so much lately—the existence of obstructives. There were local obstructives, as all medical officers knew, and imperial obstructives. The local obstructives, which was the point to which he should refer to-morrow, were now what they always had been, and always would be to the end of the chapter, that stolid, stupid, inert element of our population and every other population, with which every scientific man and philanthropist had to deal. They were the same to-day and to-morrow, and you could only overcome this by the remedy to which the Chairman had so ably alluded in the morning, the education of the people in the ways of truth and cleanliness, and a just appreciation of the health they ought to enjoy, and which Providence intended them to enjoy. He should refer to-morrow more particularly to imperial obstructives, and would only hint at them now. This obstruction arose from a bigoted adhesion on the part of our guides in the central department to the ancient ways and notions which prevailed five, ten, or fifteen years ago, without regard to the advance of science, or the conclusions of bodies such as that Conference, during the last few years—a steady adhesion to our Procustean policy, the same policy which the robber Procrustes adopted, when he said that every man ought to be the same length, and if he were not the proper length he would either cut him shorter or stretch him on the rack; and on that principle he robbed nearly everyone. That was the policy of the Central Department. There was no possibility of extracting from that illustrious body any information to guide the public. Now, the second cause, and the most patent cause of the want of progress had been the accumulation of polluted water as the result of the inordinate, reckless, and extravagant use of water-closets. It was useless to tell him that a water-closet was a valuable implement, and would carry away what you wanted to remove as quickly as possible. Where was it to go to? You did not carry it away; you simply transferred it to your neighbours; in legal language, you changed the venue, but did not abate the mischief. Was it any satistion to a Conference like that to say, as many of our towns might say, "Thank God, we have got rid of our sewage," in the same way as London had, by sending it down to Gravesend? That was the system by which the volume of pollution was increased enormously. He was within the mark in stating that, for every gallon of human excreta you carried away by the so-called water-carriage system, you utterly polluted and rendered useless for humanity, certainly for your neighbours on the river below, some 200 gallons of pure water. Consequently, in order to carry away 1,000 gallons of fæces in any one day from a hamlet, it was necessary to pump 200,000 gallons of pure water into that town, to be the vehicle of carrying it away. And what was the consequence? During the progress of what was called sanitary science of eight or ten years, the number of water-closets had increased five-fold, not only in towns but in rural districts, where, in fact, they had no means of getting rid of the sewage so manufactured. He concluded, therefore, that there was no progress whatever, and in his paper he had thrown out a challenge which he should be glad to have accepted, which was simply this, if even one of our rivers had been rescued during the present year from abomination, it would be an answer to the query set forth in the programme, and they should not be without encouragement for the future. All he could say was, that if anyone present could get up and tell him of one single river in this fair country rescued from contamination, he should congratulate him, and be only too happy to stand corrected. He would merely conclude with a short story. He happened to reside in a beautiful part of England, where there were many hamlets scattered about—a large urban sanitary district. One of those hamlets, within a few miles from London, was situated on a very fine gravel bed, at an elevation of about 100 ft. above the level of the Thames, with all the advantages of a healthy soil. Twenty-five years ago, there was in fact no disease whatever in the place of a zymotic type. Unfortunately for the district, a lady of rank came to live in it, and took a house, and she, of course, must have a water-closet. She introduced a water-closet into that unfortunate village. People, of course, followed in every way what was done by persons of rank, and, consequently, everybody else had a water-closet. There were at one time about 15 cesspools in the gardens, which had been constructed for domestic slops and house-water, and of a certain capacity. They were found to be of no use whatever for water-closets, and they overflowed directly, and saturated the gardens. The medical officer was immediately called in, and he believed the lady of rank herself was the first to raise the outcry. In the middle of that little hamlet there was a pretty little triangular piece of ground, and without saying a word to any authority, for they had none in those days, in the middle of the night they dug an immense hole in the centre of that beautiful ground, covered it up again, and made it what they called a common cesspool for all the well-to-do houses, which all opened connections for their cesspools into it. They thought, now we have got rid of our difficulty, we have a common reservoir into which we can pour our common filth. But, unfortunately, the enormous increase in geometrical progression of the volume of pollution found them out, and in less than eighteen months that large cesspool overflowed to such an extent, that it filled and poisoned every water-course within a mile, and at length found its way into a beautiful pool, where it destroyed every living thing, and produced such a mass of pollution, that the last act he had to perform as Chairman of the Sanitary Committee of that district, was to compel the owner of the pool, at his own expense, to clear out the accumulated filth of the last twenty years. That was the difficulty they had to deal with, and unless some adequate means of dealing with it were discovered, it was impossible to say that any progress had been made.

Sir Henry Cole said he might reply to Mr. Cresswell's challenge. He would not make a speech, but would simply show what had been done at Burnley. On the table was a bottle of the sewage of Burnley, which he showed. The town had been under an injunction not to pour into the Pendle River. Accordingly, Burnley made some tanks, called in General Scott's process, and produced the clear, effluent water which he showed in another bottle. It did that by putting in the lime, which was also shown, and out of the sediment it produced a cement, which was also shown, worth 40s. a ton. With regard to the cost, his proposition was that people must pay to be clean; you could not wash your hands without soap, and somebody must pay for it, but he believed the whole cost of these works was about a rate of 3d. on the rateable value of the town.

Mr Hurst said he would also reply to the challenge. The beautiful river which ran through the centre of the town of Bedford, previous to the adoption of the present system of irrigation, was very much polluted, but now you could go there in fine weather, and the water was as clear and pure as if it came from the clouds. That was without General Scott's process.

Sir Henry Cole said Bedford had plenty of cheap land,

which Burnley had not. He had omitted one fact, that was, taking the average cost of irrigation schemes throughout England, it was about 7d. in the £ on the rateable value.

Mr. Green wished to ask whether that effluent water from Burnley, within any time, and what space of time, set up an after decomposition?

Sir Henry Cole said they had heard nothing about it. The injunction was withdrawn, and the town was perfectly satisfied.

Mr. Cresswell asked what was the river upon which Burnley was situated.

Sir Henry Cole said the Pendle water was nearest Burnley, which ran into the Calder, and that into the Ribble.

Mr. Cresswell said there was great difficulty arising with regard to the Ribble at the present time.

Mr. Andrews asked if they had the water carriage system in Burnley, or the pail system?

Sir Henry Cole replied, the water carriage system and cesspool system.

Mr. Chadwick asked Mr. Cresswell, whether in respect of river pollution, he had made any estimate for the increasing surface there was of cultivated lands which discharged manures into the river?

Mr. Cresswell said there could be no doubt that one of the most important elements of pollution was the washing of imperfectly assimilated manures into the river in times of flood, but that only applied to places like the Thames Valley. It could not possibly apply to his illustration, namely, the enormous accumulated volume of sewage which had to be dealt with, in consequence of the use of water-closets in small country villages away from any river.

Dr. Syson thought Mr. Cresswell took rather too gloomy a view. During the past year a great deal had been done to prevent the pollution of rivers, as, for instance, at Birmingham, Manchester, and Salford. If they had not actually done it, they were doing it, and he was sorry he had mixed up a crusade against water-closets with his otherwise valuable paper. In these matters they ought to be eclectics, and take one thing to one place or two if necessary, and another for another. In large towns they had a great deal to congratulate themselves upon in the way of progress; where they could not do so was in rural districts, and the reasons were easy to find. Before any great national progress could be made, you must discover some ready means of enabling them to acquire land, and the necessaries for carrying out purification; nor must they look for too fine a Utopia in the rivers, for absolute perfection was impossible, even if it were desirable, for they could never stop imperfectly assimilated manures going in. If they could give corporate bodies and small local Boards a more ready way to acquire land at a reasonable cost, instead of the ruinous prices they had now to pay, they would make still more progress; but they had made a great deal, and he thought the challenge could be fairly answered. Mr. Cresswell also seemed to forget the slop difficulty, which none of the dry closet men seemed to trouble themselves much about, but he thought it might be made the means of carrying the sewage. He had no doubt himself that water-carriage, where you had a large number of houses together, was the cheapest way, unless they might, so to speak, put the sewers on wheels and carry it in that way.

Mr. Cresswell said he had in his paper suggested the very remedy to which the last speaker had alluded.

Captain Stott said Dr. Syson had alluded to Manchester having done a great deal to remove the nuisance in the rivers, but he should like to know what they had done?

Dr. Syson said Manchester and Salford were so close together, that he would take them as one; Salford had done a great deal and Manchester was doing it.

Mr. Chesshire said one gentlemen had unfortunately referred to Birmingham as a town where great improvement had been made recently. It happened that he had rooms in Birmingham, and lived on the banks of the Tame, into which the sewage all passed 25 years ago, including all the manufacturing refuse, and the sewage from all the houses. At that time it was of crystal purity and one of the finest fishing rivers in England, what had been done since? Gentlemen, like Mr. Chadwick and Mr. Rawlinson, had come forward, and insisted on Birmingham turning 15,000 water-closets into this same river, and with what result? He had three-fourths of a-mile of fishing in that river, and he pledged his word, except a few eels, there was not a fish in it. Seven years ago, if his dog went into the water it came out sweet and wholesome, but if he went in now he was so offensive that he could not bear him near to him. He held in his hand a report of the Sewage Committee of Birmingham, and throughout the whole of that report it was stated that the excreta must kept out of the sewers, yet it was not kept out; it still went in, and in an intensified degree. He had had the honour of an interview with the Local Government Board on that question, with his right honourable friend Lord Norton. He told Mr. Rawlinson then what an amount of evil was caused by the excreta being put into the house drains, that the evil really was not in the sewers, but in the drains. These gentlemen would overlook the house drains altogether, in their anxiety for sewers and sewage farms. He was a member of the medical profession, and he knew that typhoid fever, diarrhœa, dysentery, and diphtheria, and all diseases which affected the alimentary canal, were propagated mainly through the medium of the bowel secretion, and in no other way to any extent. He explained this to Mr. Rawlinson, and after giving his explanation, that gentleman began to laugh, and said that he, Mr. Chesshire, was like the Mayor of Windsor, who would have had him hanged. He said he would go beyond that, for, if he had had his way, he would have had him hanged 30 years ago, before he had done the mischief. He declared there were two men who had destroyed, by putting excreta into the sewers, more human beings than any other two men who ever lived, and those two men were Mr. Chadwick and Mr. Rawlinson.

Mr. Chadwick said there had been an attempt to get possession of land, which would have avoided all this difficulty, but it was arrested by the landed proprietors, who wanted 150 years' purchase for their property. It was to the House of Commons it was due, all this pollution being thrown into the river, which ought to have gone to the land.

Mr. Chesshire said if a thousand acres had been procured, what effect would that have had on the condition of the Birmingham drains within the borough? That was where the real evil lay.

Mr. Lawrence Hamilton said, a Chinese author, writing 11 centuries before the Christian era, said—"The disposal of stinking fish is a very difficult and a serious matter." So was it with the drainage. When he heard a gentleman say that one system was good, he was surprised, for he considered all systems were bad and faulty, though some were a little worse than others. It must be remembered that in sewage you had four distinct things to deal with; first, the sewage that came from the heavens, rain, and analysis of that rain mixed with filth from streets and houses was as offensive as that which came from the excreta of man. You had next the slops, which were very offensive and dangerous. Then there were the excreta, the solid matter, fæces, and urine. The most difficult thing was the fourth, namely, the insoluble solids, consisting of cinders, vegetables, and so forth. Although he was familiar with most of

the systems for disposing of the solid insoluble excreta from houses, he must confess it was a problem still unsolved to say how any solution of the difficulty could be arrived at. In an isolated house, situated within its own grounds, the dry system was possibly the best; but when you came to deal with a street or with towns you must fall back on the water system. They had heard a great deal about the cost of applying sewage water to the farm, and no doubt one of these days they would hear from some of those who were enthusiastic advocates of the dry system, that the only way to dispose of the excreta and urine of men and women would be to have express trains to take them down, at defecating hours, to sewage farms, so that they could there apply, without any trouble, the excreta directly to the farm. He did not wish to joke before so distinguished a body, but he had purposely reduced the system to the ridiculous, in order to show that no one method would be perfect. He put cost quite on one side, for he cared not what one system, or two, or three might cost; he would have that system mixed or pure, as the case might require, regarding more the result on the health than on the pocket. Lastly, the great mistake which sanitarians had made was this, they rather set themselves to consider the perfection of a theory, instead of looking at the faults of the practical system as it now existed. For his own part, he felt that men like Mr. Chadwick and Mr. Rawlinson might well be trusted to advise on this subject from their huge experience. The fault did not lie in the sewage; it lay first in the water-closet, and then in the leaden pipes, which, if unventilated, would only live 12 to 20 years, without being subject to a series of pimples which soon become ulcers, and shortly afterwards perforations, through which the sewer gas escaped into the house and produced weakness, sickness, and ultimately premature death. Science showed that if the pipes were ventilated they would last twice as long; and he asked those who had more mechanical knowledge than himself, to try to devise some material which should not be so easily perforated and riddled.

Mr. Chadwick suggested glazed earthenware.

Mr. Hamilton said that was very good in theory, but they could not be introduced into the house, where they had to be laid perpendicularly. They did very well in a horizontal position, or in a slight declivity, but if placed upright they were apt to get out of line, and the joints became faulty. In almost every house in London connection from the house drain to the public sewer was at fault, and the whole of this should be under Government authority, without which they could never get rid of scamping and slovenly workmanship.

Dr. Wright said one would think, from the observations they had heard to-day, that no progress had been made, and that it was impossible to sewer a town or make any real progress in sanitary matters. Now, in Cheltenham, he thought they had accomplished the matter very well, and it might be done elsewhere, provided the towns were so situate as to enable an engineer to do it, and that people would put their shoulders to the wheel, determined to make the machine work. There was no doubt the water carriage system was the best ever invented; it was the cheapest scavenger and carrier you could get. No doubt it was attended with disadvantages, but what system did man invent, which had not its disadvantages, and he believed, that system had fewer than any other, and if proper means were taken to prevent the access of sewage gas into the houses, the great difficulty would be overcome. He quite agreed that it was not in the large sewers the mischief lay, but in the connection between house and drain. The great fault of legislation consisted in allowing that connection to be made by improper parties. The sanitary authority of the town ought to see that the connection was properly made. Cheltenham was the first town which had adopted the idea of having tanks placed at the outfall of sewers, the system invented by his late friend, Mr. Dangerfield, who consulted him at all stages of its progress. At these tanks there were strainers, by which all the solid matter was kept back, and they were emptied twice a week. The sludge was taken out, and incorporated with ashes, and the compost was sold to the farmers readily at 2s. per square yard, and was found to be a very useful material, especially on heavy land with a clay subsoil. The liquid sewage was conducted to the sewage farm of about 200 acres, where irrigation took place. By that process they got rid of the sewage of a population of 42,000 from their own town, and of 10,000 more from two adjoining hamlets, at a cost of less than three-halfpence a head of the population, as all was done by gravitation alone. What they did, other places might do.

The Chairman reminded the meeting that the subject for discussion was the progress which had been made since last year.

Mr. Turner (Portsmouth) said it must be recollected, that formerly the population was a good deal more scattered than it is now; it had increased enormously in large towns, and the acreage which the town covered had not increased in proportion to the number. In the country a man might conveniently and properly use a privy, without being a nuisance to himself or his neighbours, by taking ordinary care, but in town, it was impossible to put 50 or 150 people on nearly the same space, and allow them to use privies. It became absolutely necessary to remove the sewage every day, that you might have the land to put it upon. You could not make these people use the trains, as had been proposed, to go into the country, but must take the excreta to the land. He must say he had the want of elementary chemical knowledge attributed to Mr. Chadwick, for he believed the dilution of sewage was an important factor in sewage farming; if it were used in too concentrated a form it would do more harm than good; and if it were absolutely dry, the plants would be utterly unable to assimilate it.

Mr. Haresceugh said the water-carriage system was very good for carrying away house slops and irrigating land, especially where, as in Rochdale, what was equivalent to 80 tons of soap was carried down the river every week, which would be very valuable for land. But, in his opinion, there was one point which gentlemen of the south did not seem to pay attention to. If you asked them what they did with the other refuse from the houses, they said they got rid of it, but did not say how. Now, he had recently visited the yard of the Sewage Commissioners in London, and he found there that it was sifted and separated; that the finest ashes were sold at 4s. per ton for mixing with clay to make bricks, and the cinders were sold to burn them, whilst the other refuse was burnt. Now, in the north they could not make bricks in that way, as the clay needed no admixture, and coal was so cheap that people would not burn cinders, and therefore these matters had to be dealt with to raise steam for evaporating excreta. Another point was the quantity of water used with the closet to carry away excrement, which he maintained was utterly insufficient for the purpose.

Mr. Bailey Denton, jun., then stated the substance of his paper, describing the system of irrigation adopted at Abingdon.

Mr. Chesshire asked if there were any storm outlets in the main sewer there?

Mr. Bailey Denton, jun., said there was one, but it was never used.

Mr. Chesshire asked what was the state of the sewage during a flow of storm water?

Mr. Denton said it was necessarily weak, but the land was so porous they could get rid of any quantity. Many of the houses were fitted with water-closets.

Mr. Sherman asked how deep was the underdraining?

Mr. Denton said from 5 to 7 feet; in no place less than 5 and often more than 6 feet. There was no clay, it was all loam and gravel. The water came out perfectly clear, and went straight into the Thames.

Mr. Spencer asked if it was filtered through pure sand?

Mr. Denton said through the natural soil which was there.

Mr. Spencer said he was the inventor of the intermittent system of filtration, and he thought his name might have been mentioned in connection with it.

Dr. Wright asked if the subsoil was not Oxford clay?

Mr. Denton said no; gravel.

Dr. Wright said that probably all over England they would not find a piece of ground where there were the same condition of things as at Abingdon. There was a large amount of oolitic drift, which was exceedingly porous, and wonderfully well adapted for that system.

Mr. Denton said that, in fact, the soil was no better than many other soils, though it was better than it need be.

Dr. Wright said he knew the cost at Merthyr Tydvil was very great, because things were not so advantageous there, and he could not make out how it was so different at Abingdon; but, looking at the geological character of the soil, he could now see the key to the mystery.

Mr. Austin asked to what depth the gravel ran, because the sewage must percolate through till it came to the clay, which would check any further filtration?

Mr. Denton said the gravel went deeper than they wanted to go. He could not say the exact depth.

Mr. Spencer said he might state the principle on which this intermittent filtration acted. If the sewage were filtered through mere sand without any ferruginous material at all, no purification whatever would take place. The first experiments he made were for the Corporation of Liverpool, in 1852, when it was discovered that when they had ferruginous matter in the sand it purified better than without, and that very fine white sand did not purify at all. When they had a pair of filters, so that one was lying fallow while the other was employed, it worked better, and when they added iron, especially magnetic oxide, the purification was perfect. The filter beds laid down at Merthyr Tydvil, and other places, all depended upon the ferruginous matter in the sand. He applied the same principle to the sewage water of the Calder, which was now being supplied to Wakefield. When he was called upon to advise at Abingdon, he could not get them to understand that it required a pair of filter beds, and that one would not do, but they got about 20 tons of ferruginous material and made a filter bed of it, and since that he had heard no more of it until he was told that Mr. Bailey Denton had made filters, and he had reason to believe that the ferruginous material was there mixed with sand. Whenever he had very impure water to deal with he always filtered it intermittently.

Mr. Cresswell called attention to the fact that his challenge had never been answered. The only attempt at answer was that of Sir Henry Cole, who alluded to what had been done with 1,000 water-closets at Burnley, a town containing 60,000 people, and that would probably represent 45,000, when the sewage or refuse was dealt with in another way. That was hardly an illustration of tho enormous pollution going on all over the country, not in such water as the Pendle water, but in the main arterial springs to which he referred, which were spoilt for our industrial needs. Dr. Syson remarked that he thought there was some element of proress since the last Conference, and that was in the fact that an Act, called the Rivers Pollution Prevention Act, had been passed, and he alluded to the existence of that as a sign of progress. They all hoped it would be the means of procuring that progress, and he remembered that the Chairman had expressed his approval of it. It came into operation on the 1st August, 1877, and he had watched its progress, and advised upon it in many cases, and could tell them, as a lawyer, it was almost unintelligible in itself, and most difficult to work. It could not be put in operation except by the sanitary authorities, or by individual complainants through the Local Government Board, who might be pleased then to put the sanitary authority in motion. Any sanitary authority which attempted to deal with polluted rivers must go and ask for the consent of the Local Government Board. A question had been asked about it in the House of Commons, and was answered by Mr. Sclater-Booth to the effect that something had been done towards putting it in operation, and he mentioned six places, but he did not say that in any one the Act had been put into operation, or that pollution had ceased, but that there had been certain preliminary negotiations. As a fact, he happened to know that an attempt was made to put it in operation at Hereford, which, for certain reasons he need not go into, had failed. Several attempts had been made elsewhere, and they had all ignominiously failed; but the other day he was happy to say, and that, perhaps, showed they had made a little progress at least, the County Court Judge at St. Alban's had fined certain parties £25 a day for polluting the beautiful stream there, and that, he believed, was the only progress which had been made.

Dr. Wright said that in two cases he knew the very fact of the existence of the Act, and threatening to take proceedings under it, would enable them to deal with some troublesome people, and make them perform their duty. Still, he knew there was so much difficulty with it that it was almost a dead letter.

The Chairman said he had never expressed an opinion that this would be a working measure, but he thought it would be a statutable admission of a right, and that when it was proved to be unworkable it would be amended.

Mr. Chadwick said he had recently heard from America of an improvement in a flushing machine for tanks or cesspools, by which the contents could be emptied into a subterranean drain under the land, and that great success had attended this method.

The Chairman then requested the Congress to pass to the next subject, namely, the means of preventing sewer gas penetrating into houses.

Dr. Ainley referred to the paper he had contributed, and explained the diagram, which showed how Mr. Stott's system had been applied to Smedley's Hydropathic Establishment at Matlock. It had also been applied in many other places, where it was found to work satisfactorily. Last year it was supposed that the first open grating would take in the whole of th required air, and so prevent its efficacy. But such was not the case, for he had made experiments in connection with the borough analyst of Huddersfield, by putting in sulphuretted hydrogen and vitriol, and applying the test paper at a distance of 300 or 400 yards away, close to the boiler, and found that the gas passed over that distance in about twenty minutes. The time required would depend on the number of intermediate openings.

Mr. Chadwick said the use of tall chimneys for carrying off sewer gas had been adopted in various places, with a certain degree of success, but still the gases, though changed in character, were not absolutely pure, and they were spread about the neighbourhood. There had been a plan devised for ventilating all the sewers of the Metropolis in that way, but it was found that it would have required more chimneys than steeples, and then would not have produced a pure atmosphere.

The best way was to prevent the production of the gas itself.

Dr. Ainley said the gases were passed through a furnace fire, and the worst of them were consumed.

Mr. Hawkins asked if there were any instance of the traps and the gullies being emptied by the furnace?

Dr. Ainley said the current was not strong enough for that.

Mr. Haresceugh said they had to draw away impure gases from their machines, for the purpose of consuming them, and employed one of Baker's blowers, as it was called, which, by the application of a two-horse power engine would draw away 100,000 cubic feet per hour. This gas, when sent under the fires, increased the draught of the chimney so much that they were able to do with nothing but cinders or vegetable refuse, for the purpose of raising steam. His opinion was, that if a few of those blowers were distributed about a town, and connected with the sewers, they would draw out all the impure gases.

The Chairman asked if any impure smell were noticed at the traps or gullies?

Dr. Ainley said no. That was equally true of the drop pipes leading to the houses.

Dr. Vacher said a modification of this system had been for many years adopted at Birkenhead, but instead of taking sewer gas beneath boiler furnaces, and then consuming the gas, they connected the sewers with the chimney stacks. Of course the air at the lower part was at a very high temperature, so that the air was sucked out of the sewers, and was then delivered at the top of the chimneys at such a distance from the houses that it was supposed not to be injurious. He did not think this was so good as Mr. Stott's method, because it was better to burn sewer gas than to take it up a tall chimney.

Mr. S. Alcock said sewer gas escaped into houses in two principal ways: In the first place, through the sinks, and in the next, through the soil pipe connected with the water-closets. He had found that the most effectual means for preventing that was, wherever practicable, as it was in most cases, to keep the connection with the kitchen sink outside the house, and let it fall on to a gully trap. That same system had also been applied in connection with water-closets, by letting the soil pipe from the water-closet, when it came outside the house, open into a spout head, so that any sewer gas which came up from the sewer went into the open air. The most effectual means was to make as many openings into the open air as possible. The only effectual way was to prevent any connection with the sewer going into the house at all, and that was what they tried to introduce into new houses. The great evil was the system by which house drains were laid. In Sunderland, they had a most efficient system of sewers. But after they had laid them down they found they were no use unless the house drains were properly laid, and frequently they had to be done three or four times before they could get a fall to the sewer instead of to the house. The cause of that was, that a great number of buildings were put up for sale; they were not built by the owner, but by speculative builders, who paid not the slightest attention to any correct method of laying the house drains. They had frequently contended before the Local Government Board, and that Congress last year had passed a resolution, that the laying of the house drains ought to be the duty of the local authority. It was analagous to the case of gas and water mains. Would any gas company allow each proprietor to make his own connection with the company's mains? If they did, the escape and waste of gas would be enormous; but they insisted, very properly, that no connection should be made except by themselves; and the same thing should be done with sewers. All these drains ought to be laid by the sanitary authority, which could carry them out far more cheaply. They were bound to give notice to the sanitary authority before making the connection with the sewer, but very frequently they did not do so, and after the houses had been occupied for three months it would be found that there was no connection made whatever. It was also found that the builder would make a drain 10 or 12 ft. to connect it with the main sewer, and then found he had not hit the right place. Then, instead of opening it out until he found it, he would frequently make a hole in the pipe anywhere, and trust to chance. The law forbade this, if you could find him out; but in a large town it was next to impossible to keep such a supervision over the connections as to prevent these things occurring. If this were attended to by the sanitary authorities, you would get the full benefit of the water-carriage system, there would be no sewage gas coming into houses, and the complaints made of the system would cease. He hoped the Congress would again take up the question of house drains. He believed one objection was that it was interfering too much with the rights of owners of property, but his view was that no one would be more indebted to the Government than those owners themselves, because it would increase the value of their houses. The work would be done properly and at a less cost.

Dr. Wright said he did not suppose anything said at that Conference would tend more to bring about an improvement in the sanitary condition of the population, than if the last speaker's observations were carried out. From his experience as a sanitary officer for many years, he had found that the *fons et origo mali* was the imperfect connection of the sewers with the houses. The only question was, how cheap the thing could be done. The next point was, the importance of carrying all these sink traps out of the houses, and there was no difficulty about it.

Mr. Chadwick said he had intended to have brought forward a quotation he had recently received from America, to the effect that public authorities should be not only entitled, but bound to carry away the sewage, as part of the general system of having complete control and responsibility for laying down drains.

Dr. Elliot said—Mr. Alcock has so intelligibly spoken, as to leave but little to be said by anyone following him. The general facts have been established, that sewer gas, an extensive cause of illness and of death, had, through service or connection pipes, been poisoning the air of our dwellings, that these service pipes are frequently not honestly jointed with our towns' drains; that the towns' drains are seldom efficiently ventilated; and to render the regurgitation of this gas into our houses impossible, and to make it no longer a source of anxiety, the effluent pipes, of the bath and of the sink, should be conducted to the outside of the house, where they should openly pour the waste water on a properly trapped gully, to be thereby passed into the general drainage of the town. But what of the water-closet? The soil-pipe is the most dangerous of all our effluent pipes; yet it cannot, like the others, be laid outside the house-wall, and there abruptly cut off and allowed to pour the sewage upon a gully for transmission to the main drain. We may see many ingenious devices in our museums, and abundantly advertised, each announced as an infallible remedy; and these, although really, in most cases, very injuriously arranged, are but delusions. The simple and very uncostly, yet manifestly reliable, plan, which I have adopted for nearly 20 years, is to discard all these patents and contrivances (for preventing gas from closets polluting the air of the dwelling) by the common-sense plan of placing this treacherous appendage to our modern houses outside and against the outer wall, but without any direct communication with the house, from which, under complete shelter, it is readily

accessible at any hour, or in any weather, and in slippers. I use the tank-closet, as supplied by Messrs. Macfarlane, of Glasgow, the iron trough of which measures about two and a-half yards in length internally, thus allowing of a child's seat, nine inches high, at each end of the adult seat which is sixteen inches high. At each end of the tank is the working machinery or gear; one the water supply with its ball tap, the other the strong lever for the outlet. Such a closet can be placed on the ground level, or at any height whatever, either upon iron pillars, or on supports of brick or stone. Above the door frame is a simple and efficient contrivance for ventilation and light, to the exclusion of rain and of draughts, consisting of bars of plate-glass, arranged as in a venetian blind or louvre windows, only fixed in a frame eighteen inches square, and a similar ventilating window is placed in the side wall at the same height from the floor. The lever for the outflow of this very economical closet (not half the cost of the pan-closet, and scarcely ever, by any chance, going wrong even in the longest frost), has only to be used once a day, nor in frost need it be used for many days until the frost has gone. It is unlike the pan-closet, the machinery of which has to be noisily rattled after each time of using, is heard in other rooms, requires some intelligence and attention from every one using it, and is now and again going wrong, especially in frosts, and is a constant source of danger and anxiety to those who have these health-destroying closets inside their houses, where not one should ever be. The mention of a great and realised fact I may emphatically conclude with. It is this. That typhoid fever prevails pre-eminently amongst the wealthier classes, who have closets within their houses, than amongst the humbler classes who have outside closets.

Weeks in a year = 52
Five deaths registered 5 last week

No. of thousands $\frac{35}{2}$) 260 (7·5 per 1000
245
$17\frac{1}{2}$

$262\frac{1}{2}$ or $2\frac{1}{2}$ plus.

In 1876 and in 1877, in Carlisle, we had the rate of death on several occasions down so low as eleven per 1,000, never lower. This for an urban population is wonderful.

Mr. Hamilton observed that all the powers wished for by some of the preceding speakers were already in action within the City of London. The Commissioners of Sewers assumed to themselves, by what legal powers he knew not, to do now with all new houses and with all old ones which came under their jurisdiction what was contended for; and he believed from frequent personal inspection, that the City of London proper was especially well sewered, and that the house connections were admirable. It was a great pity the same powers were not made universal.

The Chairman said the great advantage of Mr. Stott's system of ventilating was that it created a great draught. He knew it had been successfully worked in Halifax, which was a manufacturing town, but it would not be practically applicable when there was not a sufficient number of furnaces. In Halifax there were many furnaces and steam engines, and the furnaces were connected, by the leave of the proprietors, with the sewers, and thus the impure gases were drawn away.

Mr. North (of York) asked whether the fact had been taken into consideration that the outlet of the ventilation probably had much less area than the number of pipes connected with it. He understood that, in consequence of this, it would be impossible to set up anything like an active current extending over a great area, and that Mr. Bazalgette had said, over and over again, it was quite impossible to ventilate any large area by that system adopted at Halifax. He did not think the condition of houses would ever be satisfactory until not only the house drains were laid by the local authorities but until there was some authority which should dictate how these things should be done. He thought they would all agree it was very desirable that no sewer should pass under the house to a greater distance than was absolutely necessary, but in many parts of the whole town, it was necessary that the drain should pass from the back of the house to the front. He knew practically that many respectable builders would lay drains under houses without the smallest attention to the size or the level at which they were laid, and thus a constant leakage occurred for want of proper packing. It was an important matter the health of towns, for they should not only preserve the air within the dwellings from pollution, but it was also equally important to take care that the subsoil under the houses and streets should not be contaminated by the escape of sewage. It was within the knowledge of officers of health that the subsoil was often laden with sewer emanations, and became very little better than a cesspool. He therefore hoped the Conference would see its way to a positive expression of opinion that the local authorities ought to have some control over laying the house drains, and some emphatic regulation by which this should be done effectually.

Mr. Turner said that all sanitary authorities had byelaws in their own districts, the surveyors went to see that the drains were properly laid, and the connections effectually made. In the case of the drains going under the houses, they were required to be laid in concrete, and the points well secured. With reference to the escape of sewer gas into houses, they would all agree that there was one point to come before that, and that was to prevent the formation of sewer gas. They heard a great deal about water-closets, and in the new schemes proposed for the drainage of towns that was generally adopted, but often the sewers were made and water-closets connected to it, without any supply of water being provided. It was a mere truism to say that with a water-carriage system you required water to carry it, but he knew that even in many tradesmen's houses there were hundreds of water-closets depending simply on common flushing to cleanse them. Until this evil were removed, they would never get rid of sewer gas.

Mr. Cresswell asked what was done at Halifax when the factories were not at work, which, he believed, was about 56 hours out of the 144?

The Chairman said, in Halifax, Stott's system was considered rather as an addition to other methods of ventilating the sewers, than as something to be entirely relied upon. Of course, the furnace was not always going, but it was not often let out, though then, of course, this advantage would not be obtained. Still, it was a method which could be conveniently and easily employed in manufacturing towns. Nothing could be more clear or lucid than Mr. Alcock's speech: he had said nothing with which they did not all agree, but he hoped it would not be imagined that he wished to detract from the merit of his statement when he said, in justification of previous Conferences, that that was not the first time they had discussed and arrived at conclusions upon this very question. In his opening speech, in 1876, he had referred to this matter, and had expressed his conviction that they could not hope to have an efficient water-carriage system unless the sanitary authorities in charge of it were also in charge of the connections of the pipes and the arrangements within the house itself. After each of these Congresses, the Executive Committee had summed up the results of the discussions, and in those conclusions, in the year 1876, this very point was prominently alluded to. Last year a good deal of time was devoted to this particular question, and the wall was covered with diagrams of different methods for preventing the ingress of sewer gas into houses.

The conclusion then arrived at was that, although it may not be a perfect method, the most simple and obvious mode was to cut the connection. That principle was adopted by a great many sanitary engineers, and was beginning to be extensively carried out. At the end of the discussion last year the conclusions were again summed up, and the importance of this matter being placed in the hands of sanitary authorities was again pointedly referred to. On that occasion he ventured to use this argument. You have given the local authority the right to compel you to drain into their sewers, but that very right implies a corresponding objection on the part of the local authority, first of all, to take away refuse from the houses if the drains are properly connected with the sewer, and, secondly, to prevent the ingress of the sewer gas, which that sewer system created, back into the house itself. He took it, that was the moral obligation of the sanitary authority, and he did not see what answer they could make to the ratepayer whom they compelled to drain into the sewer and taxed for the purpose, unless it was that the law did not at present give them sufficient power to fulfil the obligation which the law itself had cast upon them. He did not think the law had given them sufficient power. The exceptional powers possessed by the Commissioners of Sewers in the City of London had been referred to, and in his opening remarks on the Public Health Act, passed in 1872, under which the sanitary authorities of the country were constituted, he had referred to that as a precedent. That Bill consisted of two parts, the first was constructive, which was passed, and the second dealt with direct emendations of the law which he had to sacrifice in order to carry the first. In that second part was a clause, which he, in his own mind, always called the Florence Nightingale Clause, because she had suggested it to him; a clause giving the local authority absolute power within the house as well as outside, over the pipes, drains, and connections, and imposing upon them the duty of seeing to the efficient condition of those pipes and drains. It was so phrased as to suggest, to the mind of the Legislature in the first instance, and the ratepayer in the second, that a right was being conferred upon the ratepayer of calling upon local authorities to guarantee him as to the healthiness of the interior of his own house. He was conscious at that time that the Commissioners of Sewers actually had those powers, and if it had come on for argument he should have rested his case very much upon that precedent. That created considerable apprehension amongst some of his own political friends, and in the department itself. It was felt to be a strong proceeding, and it was doubted whether the House would consent to it, but he felt it was the only remedy, and that if there was a right thing to be done, he ought to try to do it, and if the second part of the Bill had not been withdrawn, he should have tried hard to get it accomplished. During two years they had discussed this question, and had arrived at conclusions which had been formulated and put upon record by the Executive Committee. The subject had again been raised to-day, and it would be well worth considering if, instead of simply leaving it to the Committee of the Society to draw up conclusions, the Congress itself should not pass some resolution to the effect of the suggestion of Mr. Alcock.

Mr. Alcock said he would prepare a resolution and submit on the following morning.

The Conference was then adjourned.

SAVING LIFE AT SEA.—GOLD MEDAL.

Committee.—T. Brassey, Esq. M.P.; Donald Currie, Esq.; Admiral Nolloth; Admiral Sir Erasmus Ommanney, C.B., F.R.S.; Capt. Price, R.N., M.P.; Admiral A. P. Ryder; Admiral Sir E. Sotheby; Capt. Toynbee.

The Council of the Society of Arts offers its Gold Medal for the best means of saving life at sea, when a vessel has to be abandoned suddenly, say with only five minutes' warning; the shore or other vessels being in sight.

1. Preference will be given to appliances to which fewest objections are established, on the score of their occupying valuable space, interfering with the stowage of more important articles, being in the way, being unsightly, not being ready at hand, requiring more or less "fitting" when brought into use.

2. Preference will be given to appliances to which fewest objections are established on the part of medical men, on the score of the appliances being unhealthy.

3. Preference will be given to appliances to which fewest objections are established on the part of seamen, on the score of their being uncomfortable, inconvenient, &c.

4. Preference will be given to appliances which afford a buoyancy of, at least, 40 lbs. to each person on board, whether of the crew or a passenger.

N.B.—The cork life-belt, usually supplied, has a weight of 5 lbs., and a buoyancy of 20 lbs. It will float a man of ordinary dimensions, with his shoulders just a-wash, provided all the rest of his body is under water. The life-belt placed in their boats by the Royal National Life Boat Institution has a buoyancy of about 25 lbs., but only weighs 5 lbs., owing to the superior quality of the cork.

5. Preference will be given to means of flotation which utilise articles already existing on board, so that no extra space will be required.

6. Preference will be given to appliances that are the least expensive, as to first cost and annual repair.

7. Preference will be given to appliances best able to stand the variations of climate, rough treatment, &c.

8. Neither Boats nor Rafts will be admitted to the competition, as it is almost certain that in the contemplated cases of abandonment neither of them could be lowered or cleared away in time, and because, even if the Boats stowed outside could be cleared away, there would rarely be sufficient space to provide means of safety for all the crew and passengers.

Note.—Of course, if there were time to clear away boats or rafts, they would be first attended to.

9. Cork belts, with a buoyancy of less than 40 lbs., will not be admissible, as it is most important that the mouth and nostrils of every one in the water be raised as far as possible above the surface. The ordinary life-belt, admirably suited

for use in boats, and to support in the water persons accustomed to immersion in it, would frequently be quite insufficient in the cases contemplated for all non-swimmers, especially women and children.

10. No preparation of india-rubber or gutta-percha will be admissible, as with the greatest precautions they are not sufficiently proof against the effects of climate and of ill-usage.

Note 1.—It is to be understood that, under the special circumstances of the cases contemplated, all that is aimed at is to preserve life until the shore is reached, or the immersed persons are picked up. For this reason no provision is expected to be made for food or water.

Note 2.—Competitors are at liberty to draw a distinction between appliances most suitable to men-of-war, to passenger ships, to ordinary merchant ships; also between the different circumstances attending a sudden abandonment by day and a sudden abandonment by night.

The Gold Medal will be awarded for the appliance, or combination of appliances, which answer in the highest degree the various qualifications named above; but the Council is at liberty to withhold the Medal if, in the opinion of the Judges, nothing is submitted worthy of the award.

Appliances intended for the competition must be sent in not later than the 1st August, 1878, addressed to the Secretary, Society of Arts, John-street, Adelphi, London, W.C., and must in every case be accompanied by a *short* description.

By order, P. Le Neve Foster,
Secretary.

AFRICAN SECTION.

Tuesday, May 28; Admiral Sir Erasmus Ommanney, C.B., F.R.S., in the chair.

The paper read was—

THE NYASSA — WITH NOTES ON THE SLAVE TRADE, AND THE PROSPECTS OF COMMERCE AND COLONISATION OF THAT REGION.

By H. B. Cotterill.

For most minds the mere mention of Central Africa possesses a certain attraction; but when such interest is tested by an ordeal more severe than the perusal of a few sensational paragraphs or pictures, it is apt to languish and fade away. The case may be somewhat different with those who, from any reason, have a special interest—geographical, ethnological, philanthrophic, official, or personal—in these vast and magnificent regions reclaimed by the great African discovers, or re-discoverers, of modern days. But even with them, it must be confessed, the study of the subject, with its endless iterations of past history, its dreary Blue-books, and its monotonous diaries, often generates a sensation of weariness and oppression. The fact is that few, if any, travel in Central Africa—as they do travel in many other parts of the world—merely for the sake of pleasure, or the profit to be gained by the sale of a racily-written book. The pic-nic feeling soon wears off. It is no amateur "roughing," to be endured or ended at pleasure. The risks to life are great; the tension on body and mind is too severe. The constant strain on one's patience, combined with the deadly influence of fever, induces alternate states of irritability and languor in which present difficulties and details assume gigantic proportions—and these, though at the moment of supreme importance, are and ever must be, to the general public, exceedingly dry and wearisome reading.

The day may come—and sooner than we think—when passenger boats shall ply on the rivers, and find their ways to the great inland lakes; when, instead of pitching a tattered tent in the midst of a poisonous swamp, through the deep warm mud and rank vegetation of which one has been plunging for days, exposed to the terrible African sun, the traveller may be rapidly and securely carried by steam-power through such regions to the highlands of the interior; when rain-proof roofs and solid walls shall take the place of grass huts; when the fever-stricken patient shall no longer be reduced to a nauseous mess of native grain; when, ascending the Zambezi and Shire, the British tourist shall "do" the grand central tour of the lakes, with return coupons *viâ* Alexandria or Loanda.

But, however imminent, that time has not yet arrived. African travel, in most of its details, is much what it was twenty years ago, although the day of sensational exploration is already a thing of the past. The mystery of the Nile sources has been settled as far as it ever will be settled; the vast tangle of lake and river systems has been mapped out, and all the great natural features of the Continent ascertained. But the dangers and hardships of African travel are still as severe as ever; and it seems to me that our present duty—a duty that England incurs as the professed emancipator and civiliser of that land—is, not to waste more valuable life and money in abetting foolhardy and useless explorations, nor to muse agape over sensational adventures, but to use a little more common sense, zeal, and money, in securing foot-holds and centres for civilising influences, and establishing means of communication between such "propugnacula" and our base lines. There is, indeed, something of the heroic that attracts attention and admiration to a devoted band of Englishmen, advancing as a forlorn hope, unsupported, into the depths of the continent, there to be butchered—almost to a man—by the spears and arrows of savages. But, while giving them their full meed of admiration, must we not feel that such heroism might have been utilised with more profit—though perhaps with less distinction—in a more rational enterprise?

It is with special reference to the establishment of such centres and such lines of communication that I would draw attention to the region of the Nyassa, where, as you all know, a successful attempt of this nature has been already made. For those who are not familiar with the subject, I shall here premise that, following a line of action sketched out years ago by Livingstone, a Scotch missionary party, under the guidance of Mr. Young, ascended the Zambezi and Shire, and successfully launched their small steam-boat, the *Ilala* on

the lake; that for more than two years communication with the coast has been kept open, and a tolerably regular mail service instituted; and that a long line of square huts, neatly plastered and whitewashed, now stands beneath the darkly wooded heights of Cape Maclear, on the shore of a well-sheltered bay, in whose calm and azure waters lie at anchor the *Ilala* and my boat, the *Herga*, a gift from Harrow School towards the establishment of English influence on the Nyassa.

But before I speak more on this subject, it may, perhaps, be interesting to trace in a few words the progress that has been made of late in the suppression of the slave trade. It is well known to most of you—but must be repeated for the sake of continuity—that in 1873 Sir Bartle Frere was commissioned to obtain from the Seyyid of Zanzibar his signature to a treaty "for the total abolition of the slave trade in his dominions," that the Seyyid, influenced by his councillors, refused to give his signature, until threatened with extreme measures. "You will be pleased to remark," writes Dr. Kirk to the Seyyid, "that, failing the receipt of your favourable reply, the naval officers hold instructions to establish the blockade of the island of Zanzibar." The councillors were overawed, the treaty was signed, and the public slave market closed by order of his Highness, who bound himself "to take effectual measures within all parts of his dominions to prevent and suppress" the trade. But to take these effectual measuros was beyond his power. The transport by sea was indeed greatly reduced by the energy of our cruisers, but a land route was adopted, running up the coast about thirty miles inland. [Last January I crossed what is evidently this slave route, running at right angles to the Ujiji caravan road, about twenty-five miles from Bagamoio.] Early in 1874, the late Consul Elton met as many as 4,096 slaves in the course of a month, whilst exploring the country about the River Rufigi. In former years a very large proportion of the slaves imported into Zanzibar from Kilwa and other mainland ports, were reshipped for Arabia, Somali-land and, other northern regions, and it was to such destinations that these gangs, originally drawn from the parts about or beyond Nyassa, by the Kilwa slavers, were now driven by long land marches. In the same year (1874) Dr. Kirk reports that as many as 35,000 slaves passed through Kilwa. The true policy—discerned long before by Livingstone—was at length recognised, though not adopted. "I am convinced," says H.B.M.'s Assistant Political Agent in Zanzibar, "that the blessing of freedom cannot be assured to Equatorial Africa until the tree is felled at the root, and a footing established in the slave-producing districts of the Nyassa by the formation of a Government settlement." It was reserved for the private munificence of Livingstone's countrymen to initiate this policy—the success of which has been, as it deserved to be, most conspicuous.

On the diversion of the slave traffic from Zanzibar, instead of the inevitable ruin of the island, predicted by the Seyyid's councillors and other Arabs, we find a steady increase of trade, and an enlarged revenue, and that, too, in spite of the disastrous hurricane of 1872, which destroyed so many of the clove plantations. In 1876, the Seyyid, beginning to see at length that honesty was the best policy, promulgated decrees which have proved of great importance in their results. "His Highness," says Dr. Kirk, "has, at my request, issued three proclamations having the force of laws, the first abolishing slavery as a status known to Government within the northern third of his dominions; the second prohibiting the land route, by which the slavers evaded the treaty of 1873; and the third forbidding the fitting out of caravans for the purchase of slaves in the interior, and the return of such caravans to the coast, under pain of imprisonment of the owners, and confiscation of tho slaves." These proclamations have not remained a dead letter. Soldiers have been stationed on some of the principal slave routes; gangs have been confiscated or dispersed; slavers have been imprisoned—a notable example having been made in the case of the Governor of Kilwa himself, a man of high position. Before I describe the effects that this action, coupled with the vigilance of our cruisers, and the presence of the English on Nyassa, has produced in the interior, it will be interesting to compare the progress made by the Portuguese in the same direction.

It is notorious that, besides a large internal traffic, a very considerable number of slaves used to be shipped from the delta of the Zambezi and other ports on the Portuguese coast line to Madagascar. I do not wish to retail here the dreary and miserable story, so often told before, nor to rake up statistics of past years, so discreditable to a so-called civilised European nation; but rather to chronicle the dawn of a better day, for such I trust it will prove, and not merely a delusive brightening of that dark eastern sky. In a law, signed by the King of Portugal, April 29th, 1875, it is stated that "from the date of the promulgation of this law in each of the transmarine provinces, all slaves or "libertos" (freedmen) who may be brought into the provinces shall be considered to be free."

In spite of many unjust, as well as just, charges to the contrary, it is patent, from the great decrease in the export of slaves in 1876, as compared with that of 1875, that the Portuguese authorities exerted themselves laudably to cure the foul and deep-seated disease that had so long polluted and and enervated their colonies. In the latter year it was estimated that about 60 dhows, with some 7,000 slaves, crossed, to Madagascar. Of these 16 were captured. During the next year only 13 dhows are supposed to have run cargoes, and of these one alone was taken by our cruisers.

There is, however, still a very considerable traffic maintained by so-called Portuguese—some of them outlaws, and none under the recognised authority of Portugal—who hold large slave-estates about the Zambezi and Shire, and buy up victims from the Nyassa region to barter in the interior for ivory. Before leaving the subject of the Portuguese, it will be well to note that a commission which was appointed to fix the scale of wages for free labourers in Zambezi, reports that though the capabilities of that region are very great, the Portuguese are either unwilling or unable to expend the capital requisite for the development of the country. This is by no means an encouraging prospect—and I do not think it is much bettered by the fact that, since this report, certain enterprising individuals have introduced opium as the only profitable investment.

Since writing this I learn from one who has had experience in the matter for more than a quarter of a century, and who, though a Portuguese subject himself, and jealous of his country, is indignant at the state of affairs at Zambezi, that (1) the Landeen Zulus are yearly exacting higher tributes from the Portuguese; that they have descended almost to the mouth of the river, and threaten Quillimaine; (2) that though at Quillimaine slaves are free, "on the whole, Zambezi slavery continues on a great scale;" (3) that the misappropriation of public funds, granted by Portugal for the amelioration of the colony, is most scandalous; (4) that a steam tug sent out by the Home Government to assist vessels visiting the port of Quillimaine has been retained by a high functionary as his private pleasure yacht. "This is the manner," he says, "in which Portugal pretends to civilise this part of the world."

We have now sketched briefly the gradual suppression of the slave trade on the coast line; and, in passing, I may remark, that "suppression" exactly expresses the present case. The trade is in a state of suppression; it is scotched, but it is by no means dead. Were the pressure to be relaxed, it would again revive, and prove as dangerously active as ever it was.

Never, till we "fell the tree by the root"—till we establish British influence in the interior—shall we strike the death-blow.

Now, it is my opinion that the region of Nyassa is that to which, for this purpose, we should direct our present efforts; and in endeavouring to prove my case, I wish to draw special attention to one or two points, though I shall not discuss them in order, or separately. They are (1) the great advantages of a lake settlement; (2) the accessibility of the Nyassa, both by land and water, as compared with the other lakes; (3) the magnificent water-way supplied by the Nyassa itself to the very heart of the continent; (4) the extraordinarily commanding position that any settlement at the north end of the Nyassa would hold.

If we look at a map of Africa, in which late discoveries (especially those of the true outlines of the Nyassa and Tanganyika) are pourtrayed, we must at once be struck by the fact, that up the centre of the continent there stretches a great chain of lakes and rivers. With two comparatively short breaks, we have a continuous water connection from the delta of the Zambezi to the delta of the Nile. It is true that African rivers are of difficult navigation, and that African lakes are subject to violent and sudden storms; but how far such natural obstacles may be overcome, is evident from not only Gen. Gordon's success in the north, but from the fact that the little *Ilala* has penetrated, by means of this waterway, to the distance of nearly 1,000 miles.

Let me describe this route, and let those who have, or have not, had the tedious and exhausting task of marching for months by caravan routes, or no routes at all, through swamps and over sterile tracts, form their own conclusions, and act upon them.

At present, on the Zambezi and Shire rivers, below the Murchison cataracts, there is no means of conveyance except by native canoes, or the boats belonging to the Scotch Mission. From Quillimaine, at which port the Union Company's steamers now call regularly, one paddles up against the rapid current of the Kwakwa, a false mouth of the Zambezi, with the main stream of which it is connected only during the floods. We reach, in about six days, Mazaro, a village on the left bank of the great river, where there are a few native and Portuguese houses, cocoa-nut and palmyra palms, mango trees, an official, and a flag-staff. The journey up to this point is by no means interesting. The country is flat and swampy; there is little or no game to be seen, and the natives are by no means improved by contact with a semi-civilisation. When, however, a station is formed at the Kongone mouth of the river, the voyage through the delta will be far pleasanter and shorter, especially if a steamboat of shallow draught is placed (as I have reason to believe will be done this summer) on the lower rivers. The journey from Mazaro, up the Shire, to the foot of the Murchison cataracts, takes about fourteen days in a canoe. In a steam-launch it could easily be accomplished in six or seven. At the cataracts there is a break of about fifty miles, a distance easily traversed by men with loads in three days. A fairly good path ascends the right bank, leading through a finely-wooded country, alive with game, and past several magnificent rapids and falls. From the left bank a good straight road (the first completed in Central Africa) has been made by the missionaries, leading past the station of "Blantyre," which is situate in a lovely spot among the hills, some 3,000 feet above the sea. By either of these routes one reaches the upper river, at Mpimbi, or Matope's, whence, in the little mission steamer, one is carried up past the grand ridges of Mount Zomba (7,000 feet), through the papyrus-fringed lakelet of Panalombe, till, on the third day, the river opens out into a vast expanse of dark-blue waters, bounded in the dim horizon by lofty ranges of mountains. The little vessel rises and sinks on the great ocean-swell, and we are on Nyassa.

Leaving astern the swampy banks, alive with huge crocodiles, between which the Shire sweeps down, we steer N.W. towards the grand dark promontory of Cape Maclear, passing rocky islets tenanted by terns, divers, darters, (*plotus*) pelicans, and other water birds, while on some solitary fig-tree, that clings to the highest crag with its snake-like roots, the great fish eagle, as he watches his prey in the transparent depths below, utters aloft his weird scream—a scream that lives for ever after in the memory. Past little sandy bays and jutting points, where the gleaming rocks break the swell of the lake—noonday haunts of the great river-horse—we glide along, here and there catching glimpses of native huts nestling among the dark forest trees, till, rounding the steep Cape, we are in the calm, deep waters of Livingstonia Bay.

Those who know the eastern shores of Lake Leman, about Chillon, or the sea-line of the Riviera, will be able to form a conception of the scene. The lofty granite ridges and slopes of the promontory, clothed to their summits with dense foliage, close round us as we sail under the lee of Bird Island, and drop anchor near a shelving sandy beach, opposite a row of square, grass-thatched, huts—the home of the white man on Nyassa. The Europeans on the Lake number about ten. Since the little *Ilala* first found anchorage in that

placid bay, since the first tree was felled, and the first hut, built by Mr. Young, Dr. Laws, and their sturdy Highlanders, the party has been increased by new arrivals, and decreased, alas! by death. But when we consider the extraordinary fatality that has dogged the footsteps of African pioneers, when we contemplate especially the sad experiences of our Universities' Mission, it surely proves indisputably the comparative healthiness of the Lake regions, when I state that, during a period of nearly three years only, one white man alone has died from fever on Nyassa, and he, poor fellow, had shown great susceptibility to malarious influences soon after he landed in the country. The time at present necessarily spent in the low marshy coast-region, with its dense chilly mists and stifling damp heat, during the slow ascent of the rivers by boat or canoe, is amply sufficient to poison the blood, and to sow germs of the dangerous coast-fever, and to this form of the disease (though in a mild form) one is liable for months after reaching the clear, bright atmosphere of the Lake.

No white drenching mist here collects at night. Day after day, during the greater part of the year, the dawn breaks with cloudless splendour. A cool breeze ruffles the surface of the bay, and dies away with the rising of the sun. At such a time, or when the sunset is burning behind the great Umfata mountains, most delicious it is to paddle about the rocky nooks and islets of the lake, or stroll along its margin, with rod or trolling line; for there are fish to be caught, and worth the catching. At night—especially during May and June—strong gusts of wind come raving down the gorges of the hills, howling fiercely through the forests, and sweeping away across the Lake. Before the rains set in, great masses of clouds are brought up by the S.E. monsoon, and thunder rumbles and re-echoes incessantly among the mountains.

A few hours' walk from the English village brings one to a fine plain, where koodoo, pallah, wild boar, eland, buffalo, and occasional elephants, are to be found. The south-western heel of the lake, bordered by a large marsh or "sponge," is the resort of hippos. The fish of the lake are very numerous, and many of them are beautifully coloured. One, the "mpasa," or "ilawa," is like a fine salmon-trout (though not a true salmon) of about 6 lbs. Another, the "kadiokola," has scales of green and gold, and runs to 8 or 9 lbs. I have caught, with spinning-tackle, as much as a cwt. in the hour.

For the sake of variety and local colouring, I shall now give a short description (though it may appear shorter to me than to you) of some expeditions that I made in various directions. After my first rainy season, I started off to visit a chief, Tambala by name, who lives some fifty miles to the westward of Nyassa, in a region untrodden by any white man, though Livingstone was in its vicinity on his last journey. Tambala was said to wish for our friendship, and I was all the more desirous of cementing this friendship because Mpemba, his neighbour, the greatest slaver of those parts, had declared his hostility to us in unmistakeable terms, threatening to cut the throat of any white man who landed in his territory; and this hostility had been deepened by an act, perhaps, impolitic, but one which no Englishman could have refused to perform. We had rescued about 24 of Mpemba's Manganja subjects, who had fled in fear of enslavement, and were starving on a little barren island, whither they had escaped, and where their canoe had been dashed to pieces on the rocks.

But to return: the chief interest in this short expedition of mine lies in the fact, that on the road I met three gangs of slaves, and discovered—what was only too plain from the number of abandoned slave-sticks, as well as from the revolting sight of two recently dead bodies lying across our path—that a very considerable slave-route ran round the heel of the lake, and passed, utterly unknown to us, within eight miles of the station. I crossed the great Umfata range by a pass about 3,000 feet above the lake, a magnificent view of which was gained from the summit, while below me, towards the west, I found a hilly plateau, and in the dim distance the low valley of the Loangwa, and great serrated masses of mountains. The highland inhabited by Tambala is very fertile, and its scenery most beautiful—deep valleys and open woodlands, through which the Lintipe, Livise, and a hundred other streams, rush foaming downwards to the Nyassa. The chief, and his son Mlenga, received me well, offering me land, ivory, and wives, if I would settle in his land. No Arabs have dealings here. I saw no trace of slavery, and found a great quantity of ivory—though I had not enough cloth with me to make large purchases. I much hope that some day soon an English mission may find its way to Tambala's country.

Last June I made a longer expedition in my boat, up the west coast of Nyassa. After visiting the little Lake Chia, which communicates with the great lake by a broad channel some three fathoms in depth, and having been courteously received by the Arab Jumbe, of Kota Kota, where an immense and excited crowd lined the shore and the roofs of the houses when my boat hove in sight, I passed the towering mass of Mount Kuwirwe, and reached the Wa Nyassa, a people hideously disfigured with enormous lip-rings, and of most evil odour, by reason of a stinking oil and red paint, wherewith they clot their hair, and besmear their faces.

Here the Arabs never venture to come, for fear of the Mazitu, or Mangoni, a marauding Zulu tribe In spite of their bad name, I found these Mangoni most friendly. Their great chief, Chipatura, did not visit my boat, for he disliked the ants which infested the marsh in which I had found shelter. But he sent one of his wives— a pretty and dignified little creature—with some of his councillors, splendid fellows, got up in jangling bangles, feathers, and tails. I had hoped to reach the N. end of the Lake, but a sudden storm at midnight drove my boat ashore near Mankambiras (about lat. 11° 40′), and I lost a great deal in the furious surf. Luckily, the natives were very friendly, and gave me effectual aid in rescuing the boat; but after pushing on a day or so, and visiting the chief of the Wa Nyassa, a fine old man, who entreated me, as usual, to stay with him for ever, and made the usual enticing offers of land, wives, &c., and actually gave me a tusk, which I promised to show to my countrymen as a token of his friendship, I found that my boatman was so ill that I had most reluctantly to turn back. He had jumped over-

board at the time of the wreck. and had caught a fatal chill. It took me many weeks to return, for the S. wind blows at this season like a monsoon. Day after day I would lie in some sheltered bay, or river mouth, watching this inexorable Mwela, as the S. wind is called. At length, by dint of long pulls—sometimes of twenty hours at a spell—I reached the station, where soon after my poor boatman died. My impression gained from this voyage —and greatly confirmed afterwards—was that the more northerly parts of the Lake are far more fertile, more beautiful, and more populous, than the granite country of the South.

The amount of ivory that I saw was very considerable, the tusks of good quality, and often of 60 to 80 lbs. in weight. I bought a few, giving for large tusks cloth and beads at the rate of about 1s. 6d. per lb., taking the English value of goods, which would be certainly not more than 3s. a lb. with Nyassa price of cloth. Smaller tusks were to be got for much less; hippopotamus teeth for about 3d. per lb. From accounts that I have read, I believe this compares very favourably with the price given in West and South Africa. The operation of purchasing a tusk is, however, exceedingly tiresome, and demands a vast amount of patience. On an average each tusk took about six hours of haggling, and sometimes the bargain came to nothing till two or three days had been expended over it. I do not think (with the exception of the precious metals, evidences of which are to be found —and perhaps nitrate of potash or soda, a large lake of which, Hikwa, lies to N.W. of Nyassa) that any of the present products would pay cost of transport. Cotton grows wild, and is also cultivated by natives, especially on the Shire, the valley of which river would make a splendid cotton field, while the neighbouring hills would afford a healthy retreat for the white planter. Sugar-cane, grains of various kinds, yams, bananas, &c. grow luxuriantly. Indigo and coffee would probably thrive. Of gum copal, I saw none about the Nyassa. The timber is fine, especially towards the north, though at the station complaints are made as to the quality for house building. I had now gained all the information that I required as regards ivory and the prospects of trade, and was resolved to return with the hope that others might take up the work in a business-like fashion—a hope that has been already fulfilled. I, therefore, went down to the Shire cataracts to collect men for the land journey to Zanzibar, and met the late Captain Elton, Consul of Mozambique, with some friends of his, who, I found, was bent on a similar undertaking. So we agreed to travel together. The little misson steamer took us at great risk (indeed she was twice nearly lost) up the lake, during which voyage we visited various chiefs on the Nyassa, and were the first white men to land on the northern shores. Near Kota-Kota, Elton and I discovered a small lake called Chiningala. I ascended Mount Chombi, on the West Coast (4,500); we saw vast herds of elephants, of which four were shot in one day, and finally ran into an estuary at the north-west corner of the Lake, called Ruambadzi, and found the country inhabited by an unknown tribe, the Wachungu, who, though in many respects very high in the scale of barbarism, tilling the land as I never saw it tilled in any other part of Africa, keeping large herds of cattle, building brick huts, and making beautifully-wrought spears, &c., were in a most primitive state as regards clothing, which consisted entirely of nothing, or of an occasional banana leaf.

Of our land journey thence over the huge range of Kondi to Merere's, where we were besieged in a stockade, and suffered much from privation, of our passage through deserted and unknown regions, nearly starved to death, and of the sad end of my companion just as we reached the Ujiji caravan-road, having had to make a long detour to the north of some 800 miles, I shall say no more now; as the Greek poet remarks, " A great ox is standing on my tongue."

The present state of the Nyassa slave trade, as compared with that of former days, is, I fully believe, most encouraging. It must be remembered, that the organisation of large caravans for the coast is a speculation which, if successful, brings great gains—if unsuccessful, great losses. The consequence is, that as all who were acquainted with the subject predicted, the system was likely to bear pressure and tension up to a certain point, and then would come the collapse. We found evidence to show that such a collapse had taken place. At various slaving centres we found large gangs that were being retained by the Arabs and native chiefs, who were afraid to send them to the coast. A similar state of things was found at Mataka's, on the road to Nyassa from Kilwa, by a member of Bishop Steere's party, by another missionary in the region of Mombassa—and I hear that General Gordon gives a similar report as regards Lake Albert. As I said before, the thing is in a state of suppression, and we may hope that ere long—though an intertribal slave traffic will exist for many years—if we do not relax in our efforts, the exports of slaves from Central Africa, the horrible barbarities connected with which have by no means been overstated by travellers, will be a thing of the past. Do not misunderstand me; let not a glow of comfortable self-satisfaction arise in the heart of the philanthropist at the thought that England has exterminated that iniquity. Englishmen, both abroad and at home, have, since the time of Livingstone, done something towards fulfilling the glorious task that England has ever been the foremost of nations to undertake. But much remains to be done, and I trust that, even amidst the discordant tumult of voices that call on England to defend her own interests, she may not forget the interests of others.

Once more, in conclusion, I draw your attention to the great facilities afforded by the Nyassa for placing a settlement in the heart of Africa, and the advantages of communication that it would possess. We have a water-way, with one short break, of about 1,000 miles in length, by which we could reach the north end of Nyassa in some three weeks. To this point a direct road from the coast of about 300 miles (half the distance of any other African lake from the sea) has already been begun by the munificence of one or two private individuals (whose names will possibly be brought more before the public ere long). Then a land journey of some ten days will connect this settlement with the southern extremity of Tanganyika; and lastly, such a station would command all the country to the west of the Nyassa—all the ivory-wealth of the

Uwvisa land, and the south region of Tanganyika, which is now diverted by very circuitous routes through Ujiji to the north, or Kota Kota and Kilwa in the south.

There are several questions of interest which I have no time to treat; one, especially, I should much like to hear discussed by anyone who has had practical experience of the subject, viz., the possibility of taming and using for transport the African elephant, before he is exterminated by ivory-hunters and sportsmen. I have never had much sympathy with the so-called sportsmen, who indiscriminately slaughter these magnificent and sagacious creatures for the mere "fun of the thing," and my antipathy has increased since over our camp fires I and the late Captain Elton talked over the possibility of using them, in place of Pagazi, for transport across the vast plateaux and swamps of Central Africa, where, whether from the tsetse fly or other causes, horses and oxen prove a disastrous failure.

I have, I fear, far exceeded my prescribed limits, exhausted your patience, and told rather a dull tale. But, especially before my present audience, I would rather appear to insist on the practical part of the subject, than to excite a momentary interest by the relation of thrilling adventures, such as may be read, and forgotten as soon as read, in the last book of fiction, or of African travel.

DISCUSSION.

Mr. Cotterill, in reply to questions, said that Mr. Young's first object was to find a well-sheltered bay, and he believed the one at Cape Maclear was almost the only one on the lake. With regard to the healthiness of the settlement, there was no marsh within many miles, and there had been no attack of dysentery; nothing beyond a little highland fever, which would lay a man down in the morning, and he would be all right again in the evening. The fever which was found on the lake was generally brought up from the low country. He had no doubt the climate there would be found more healthy than that of India, especially when they got good houses and food. He could hardly say much yet about the future prospects of the settlement, but it would have to be supplied with food from more fertile regions. The great difficulty was to combine the two requisites of healthiness and fertility. Wherever there was a marsh the ground was like a garden, and the natives could live there well enough, but Europeans could not. Whether Dr. Stewart would feel justified in changing the position of the settlement to one higher up the lake, he could not say. He could not speak positively whether the *tsetse* was found in the neighbourhood; he had examined a great many flies which were similar, but he was not sure about it. The cattle pined away and died, but the natives attributed it to the grass. There were no cattle there, but all the villages in the immediate neighbourhood were too poor to possess any; there was a legend, however, that cattle were formerly kept almost on the site of the present station.

The Chairman asked if any civilising influence had yet been exercised over the natives?

Mr. Cotterill said a good many men came from the village to be taught how to build, make bricks, use tools, and so on, and some of them had become very proficient, but he could not say that any arts had been yet introduced into the native villages. The Portuguese had made some reductions in the duties, and now termed them transit instead of import duties, which was satisfactory, inasmuch as it showed they did not claim the territory inland.

Dr. Mann said all present might not be aware who Mr. Cotterill was, and he might, therefore, perhaps with some advantage, state that he started for the Nyassa district in 1876, his object being to investigate independently as far as possible the best promise for the introduction of of commerce into those regions. He was a year on the lake. Before entering upon this expedition he was a master at Harrow, where the other masters and scholars presented him with a steel boat, which he had referred to. When he went out he landed at Quillimain, ascended the Kwakwa river, transported his boat across the land to the Zambezi, went up the Shire to the cataracts, and thence made his way on up to Livingstonia. A few months ago he was spoken of in this country as probably a lost man; a rumour came home of the steamer being cast away on the lake, and for a long time nothing was heard of those on board. Mr. Cotterill, however, made his way round the north of the lake, and so down to Zanzibar. The mountain pass which he went through on this journey was most interesting geographcially. The mountain range which it traverses was first heard of through Livingstone, who got about two-thirds up the lake and then returned. It was only since then, by Young's voyage up the lake, that it was discovered that the whole of the east side at this end was skirted by the range of mountains sighted by Livingstone, and through a pass in this range about 9,000 feet high, Mr. Cotterill made his way, to the Ujiji caravan road, and so down to Zanzibar, losing his companion, Captain Elton, on the road, but finally reaching England himself in safety, to give the account of his expedition which is now preparing under his hands. This range was not yet put on the map, but he hoped that by degrees they should be able to fill it up and make it complete.

The Rev. Mr. Waller remarked that Mr. Cotterill had been very reticent in speaking of his journey from the north end of the lake to Zanzibar, but it was only due to him to say that he stood by Captain Elton, the leader of the expedition, to the last, and helped to lay him in his grave. He also brought back to England with him all Captain Elton's sketches. These were so valuable, that Lord Derby sent them to the Queen, and they were considered by the Foreign-office the most beautiful set ever made by an English traveller. He must add that he believed Mr. Cotterill's reticence was in great part due to the fact that he was busy editing Captain Elton's notes and sketches, which he hoped would be published in November. Perhaps no man was ever cut off in the midst of a more industrious career; he laboured from morning to night to lay before his chiefs at the Foreign-office the most exact details of his observations, and he had never seen such a mass of useful work collected together, always excepting Livingstone's, as that which he had sent home. A great many useful facts were derived from this exploration; in the first place they found that there was at the top of the lake a powerful chief called Merere, of whom Livingstone heard a good deal. It was very important to have a half-way house there, and still more to have a good friend in this powerful chief, and he believed it would be found, when they perused Capt. Elton's journals, that Merere would be a friend to the English, and a support of all enterprise in that district. Again, the question of cattle was a very important one, as bearing on the question of transport. They all knew of the water ways, but they must have some means of getting across the mountains. Camels hardly seemed to be thought of yet, but the country teemed with cattle. Many most laudable enterprises had been set on foot, and though all had hitherto ended in disaster, he for one did not despair. He thought the proper way would be to follow out the plan adopted more to the south, and carefully map out the *tsetse* districts and avoid them. South of the Zambezi natives would take you anywhere, but they oftentimes followed a circuitous route, and passed certain districts only at night, in order to avoid the fly. This would come in time, he had no doubt, but those who rushed headlong at it, and would travel in a

straight line, must pay for their experience. He knew that Captain Elton had recommended the use of elephants; it was certain they existed in great numbers, and were very docile animals. He himself had ridden on an African elephant in the Zoological-gardens, and only that morning, in coming up to town, he saw one walking along the road with a menagerie. He would suggest that the Society of Arts could not do a wiser thing than offer a prize of £100 to the first man who should ride 100 miles on an African elephant in the interior of that country. With regard to the health of Europeans, they were beginning to appreciate the advice given years ago by Livingstone to go up to the high ground. The death-rate on all the coast settlements, missionary or otherwise, was hideous, but elevation meant health, and it was entirely a question of getting high enough. Mr. Cotterill had told them of the comparative health enjoyed on the lake, but he might have gone further and spoken of the superlative health at Blantyre, which was some 2,000 feet higher. He had seen many letters written from there by young Scotch gardeners, none of which contained even an allusion to sickness. All those who were connected with African enterprise should insist on the men getting up to the highest ground, for although they might exist on the lower ground, they were useless to themselves, and all about them, got peevish, low-spirited, and out of sorts. Here Mr. Cotterill had done inestimable service. He had passed through a country which he described as similar to the Riviera or Switzerland. Again, coming to the question of ways and means, there were but few things absolutely necessary to Europeans on these high lands. Of course men who undertook mission work there would not want all the delicacies of civilisation, but they must have coffee, wheaten flour of some sort, and sugar. Now Mr. Cotterill would tell them that he had seen the sugar-cane growing in many places, that corn would grow very well, and coffee was indigenous, at all events it had been found in many districts. Therefore, if they could get men on to these high lands there would be anything but a cheerless future before them. Mr. Cotterill had also introduced some of these natives to civilisation, and that would be of great service in dispelling the fear which they entertained. He remembered that when they liberated a great many slaves in the neighbourhood where Blantyre now was, they were much astonished to find that the English did not eat them at once, and when they were fed up into good condition, they thought they saw the design, and that it was only preliminary to making a feast of them. Often ten or a dozen would make their escape and run back into slavery to avoid a worse fate. On one occasion, however, he got permission from Bishop Mackenzie to take a few lads down to see the steamer. It was rather a dangerous experiment, because if they had got alarmed and run away, he would have been accused on his return of having eaten them; however, happily this did not occur; they went down to the steamer, where the sailors made much of them and gave them clothes; and when they came back they soon dissipated the fears of their comrades, and every one else wanted to go and see the steamer too. These men, whom Mr. Cotterill had taken with him, would go back and tell the natives that the Sultan of Zanzibar was determined to crush the slave trade. That monarch had entered heart and soul into this matter, and was doing spontaneously all that an honest man could do to put an end to the slave trade. He hoped the time would come when the English public would be less occupied with more pressing matters, and that then his efforts would be more recognised.

Mr. Hutchinson said the importance of this settlement on Lake Nyassa was very great, both as regards commercial and missionary enterprise; but a great deal still remained to be done before the position could be accepted; as likely to play a great part in giving access to the interior of the continent. Mr. Cotterill, somewhat following the views expressed by Mr. Stephenson, seemed to look forward to the time when there would be a waterway by the Shire up to Lake Nyassa, then a route by land portage to Tanganyika, and then by another little land portage to the Victoria Nyanza, and thence down the Nile.

Mr. Cotterill said he had discussed this matter with Mr. Stephenson before that gentleman wrote his pamphlet, but he did not suppose this would ever form a route from Cape Town to Liverpool; but the coast being so very unhealthy, he looked upon the centre as the part to be settled, and to form a communication from one district to another. He did not think it would ever pay to go up the Nile.

Mr. Hutchinson thought it must be manifest to anyone acquainted with the interior of Africa that it must be a long time before they could speak of the route between the north of Lake Nyassa and the south of the Tanganyika as a simple land portage, for they knew very little as yet of the communication between these two lakes. There was no doubt that Lake Nyassa was a very important centre, and there were opportunities of developing traffic from thence to a very large extent. He was thankful to hear that the arrangements with Portugal would result in a more favourable system of duties, because if protective duties were imposed on the water way it would throw great difficulties in the way of trade. One point of importance was this, that as he understood Mr. Cotterill, he did not think there was any article which would pay for export from Lake Nyassa except ivory.

Mr. Cotterill explained that he meant only with the present means of transport.

Mr. Hutchinson said one would naturally wish to see every part of Africa developed to the greatest possible extent. He hoped Nyassa would play its part in the future, and that there would be a healthy thriving settlement planted upon it. He quite agreed with Mr. Waller that if health were the only object, they should aim at getting on the high lands in the interior; but he might point out that Englishmen were content to swelter in the swamps in the delta of the Niger and the Bight of Benin, for the acquisition of wealth; and if there were an enterprise of any kind open not only for the pursuit of wealth, but for the moral and spiritual benefit of mankind, Englishmen would stay on the coast. On the Zambezi, and on the fever levels in Zanzibar, missionaries were at work, and would no doubt continu their labours there. He must confess that he heard with regret that the African Exploration Society, connected with the Geographical Society, was about to run its head against the wall which Mr. Cotterill had shown to exist from Lake Nyassa far towards the north. About the time when Mr. Cotterill was thinking of his journey a paper was read before this Society, in which it was stated that these very mountains which deflected Livingstone and Roscher in their journey to the Lake, and which Vanderdecken saw, were probably part of the chain, which only 130 miles further north at Zumpman were 6,000 feet high. It was not at all likely that such a chain would suddenly disappear, or that such large passes would be found as would allow of a road being made straight across, to the north end of the Nyassa Lake; and the information conveyed in that paper was supplemented by a note from Mr. Keith Johnson, on the authority of an Arab, stating that the River Rufigi flowed for a considerable part of its course through a high and rugged mountain chain. With regard to the slave trade, he would echo all that Mr. Waller had said. They ought to be thankful that in ten years they had seen the efforts in which Mr. Waller and others took so much interest crowned with success, and that what took England 100 years to put down on the West Coast had here been suppressed in ten. No doubt inter-tribal slavery would continue, but the external trade had been

suppressed, as would be stated by the Foreign office, for the Arab merchants no longer found it pay to fit out caravans. The efforts of Col. Gordon and Capt. Malcolm on the Red Sea, combined with what was done by England and by the hearty co-operation of the Sultan of Zanzibar, had practically suppressed this slave trade. He thought the remark of Mr. Cotterill in the early part of his paper, where he spoke of a band of Englishmen "being butchered almost to a man," if he meant it to apply to the Church Missionary Society's party reaching the Victoria Nyanza, was rather too strong, as they only lost two Englishmen, and nine others were now finding their way there. They must all be thankful that there were so many diverse streams of influence converging on the interior of Africa. They hailed the work being done on Lake Nyassa by their Scotch friends, and the Church Missionary Society were going to work on Lake Nyanza, so that the whole of this vast chain of water-way, which practically represented the theoretical discoveries of former missionaries, Rebman and Krapf—would be in the hands of English enterprise, he hoped, in a short time. Strong representations had been made to their society with regard to the use of elephants. They had tried oxen, but had been beaten by the *tsetse*, and he was afraid they could not wait until they had learned how to dodge that destructive insect. The use of Indian elephants had been suggested, but there were great difficulties with regard to their food, and he understood that, when domesticated, they were very delicate. He would venture to recommend that the prize suggested by Mr. Waller should be offered for the first tamed African elephant. The great difficulty to be got over was the abominable habit of the Arabs and Africans of eating everything. Sir Samuel Baker caught a young elephant, but, as soon as his back was turned, he was killed and eaten. He saw no reason why young elephants should not be caught and tamed, and that would go a long way to solve the difficulty of transit. If this failed, he thought it might even be worth while to try Mr. Haddon's pioneer railway. He found it cost about £700 to send £1,000 worth of cloth to Lake Nyanza, and while this was the case it was impossible to introduce English manufactures into the country in any quantity.

Mr. Cotterill said he should be glad to alter the phrase with regard to the Victoria Nyanza party if possible, but he understood it to be the fact that only one white man of that party survived.

Mr. Hutchinson said there were only three. Mr. Wilson, the one who survived, had spent six months at the court of King Mtesa, who, when he heard of the slaughter of their men, immediately sent off Mr. Wilson in the mission boat, and the Society had since heard from him at Unyanyembe. During the six months he stayed at Uganda he received the greatest kindness. and he testified to the remarkable advance which had taken place in the general morals of the king.

Mr. Cotterill said, with regard to the comparative cost of transit to the Nyanza and the Nyassa, that he went out by the mail steamer to Port Elizabeth, whence he had to charter a steamer to the Zambezi; and there he had to pay a very light duty; and he calculated that when he got to Nyassa the cloth he took was worth just double what he had given for it in London; but now, with the reduced tariff, he looked forward to being able to convey goods to the north end of the lake, which was a considerable way into the interior of Africa, with perhaps 25 per cent. added to its value. With regard to the communication between Lakes Nyassa and Tanganyika, the natives said they could do it in ten days easily, and that there were no mountains on the road; they looked upon it as a common journey. When they had once crossed the high range of mountains, they came to vast plateaus which went down by large steppes to the sea, and along this tract there was formerly a good caravan road.

The Chairman said he had heard many travellers recount their experiences, but had never heard anyone bring more vividly before the mind a picture of the country he had travelled through. He observed that he had cautioned his hearers not to be too sanguine that the slave trade was abolished, because somehow or other the traders would manage to get off the coast. He had a nephew stationed there in command of a ship, and since their last meeting he had heard of his having made a valuable capture, and during the 18 months he had been there he had considered himself very successful in making prizes. While giving every credit to the Sultan of Zanzibar, they must not forget the great work done by the British navy a century ago on the West Coast, when men were often kept in the old ten-gun brigs for six or seven months at a time on one station, sometimes without even the excitement of a chase or capture. He could not help being much impressed with what was being done at Lake Nyassa, and if that was such a good station, on the ground of salubrity, what must Tanganyika be, which was more than 1,000 feet higher, and so also with the Victoria Nyanza. Looking at what Stanley had accomplished on the Congo, which seemed to be really one of the great arteries of Central Africa, it occurred to him that sums such as those which had been spent on Arctic exploration might be well bestowed in surveying that great river, a task which seemed to be too great for any private enterprise to accomplish. He concluded by proposing a hearty vote of thanks to Mr. Cotterill.

The vote having been unanimously accorded,

The Chairman announced that this terminated the meetings of the African Section for the present Session, and he was pleased to think that much valuable information had been made public through its instrumentality.

MISCELLANEOUS.

BURNLEY SEWAGE.

In May, 1872, General Scott read a paper before the Society descriptive of a method of dealing with sewage precipitates, and then described how, by means of fire, the sludge deposited, after precipitation by lime, could be converted into a strong and saleable cement. That purification by lime will produce a clear effluent, and one which, thrown into a river of sufficient volume, will ensure a satisfactory result, is admitted by Royal Commissions and leading chemical authorities, but the great difficulty remaining has ever been how to deal with the vast accumulation of sludge that necessarily takes place. In some cases, as at Birmingham for instance, it costs the town £14 per acre to dig it into the land, which the Corporation has secured in connection with its sewage works, whilst at Leeds and other places it has been a source of great trouble to get rid of at any price. General Scott, however, discovered that the sludge, when dried, contains in it sufficient combustible material to act as a fuel for burning it; and he thus, at a moderate expense, converts the sludge into a powerful and useful cement of the character of Portland or Roman, according to the constituents of the sewage from whence it was derived. Repeated experiments on a more or less extended scale showed the practicability of the process. A few days since a large party, consisting of the Mayors of Burnley and the neighbouring towns, with the chairmen and members of sanitary authorities in Lancashire and Yorkshire, met together, by invitation of Scott's Sewage Company, to inspect the works lately erected by the Corporation of Burnley for carrying out this process on an extended scale for dealing with the sewage of Burnley.

The Corporation of Burnley was prohibited by in-

junction from allowing the effluent from their sewers to flow into and pollute the River Calder. The Corporation and Scott's Company entered into a contract whereby Scott's Company engaged to produce and have produced a clear effluent. The injunction has been got rid of, and the Corporation has recorded its satisfaction at the results which the company has attained. The works at Duckpits, a short distance from Burnley, have been erected by the Corporation, after the designs of Mr. W. B. Bryan, C.E., which exemplify the latest scientific views on the subject, in order to deal with all the sewage of the town and district except in time of floods. The Corporation deliver the sewage into the tanks, and then Scott's Company purifies it by lime precipitation, to be supplemented eventually by filtration, through coke if required. The clear effluent passes into the Pendle water which joins the River Calder. The stream into which Colne and Barrowford, Nelson and Brierfield pour their raw sewage is at present unpurified. The Calder below Duckpits also receives a considerable amount of sewage before it joins the Ribble. Duckpits thus placed, as it were, between two sources of impurity, presents a case of some difficulty. How it is met on the Pendle water is shown by the pure effluent discharged into it. The sludge, always an offensive difficulty, is entirely cleared away by its conversion into cement (Portland and other hydraulic and Roman cements). All that has hitherto been made has been sold or used in the works. The cement is sold with a guarantee as to the strength and quality. The company is open to make contracts with any other sanitary authority. The nature of the contract and the cost of working the process depends on local circumstances.

The sewage from the town passes into four settling tanks, after receiving the proper dose of lime cream previous to entering them. After settlement, the time for which varies from a few days to a fortnight, according to circumstances, the sludge is pumped into draining and drying "backs," from whence it is dug out and carried to a heated drying floor. When sufficiently dry it is packed into kilns and burnt, the only fuel used beyond that which it contains being a small amount of coal and shavings to set it alight. At the end of a few hours the kiln is drawn, the "cement clinkers," as they are termed, are ground into a coarse powder, which forms the cement. The cement is readily saleable as Portland or other hydraulic cement, according to the character and treatment of the sludge. It is understood that these are the first works on a commercial scale for carrying out the process. The Corporation are satisfied with the effluent, and the company feel assured that the results of working up to the present time are a money success.

A meeting was held on the 1st of June, at Stafford-house, presided over by the Duke of Sutherland, for the purpose of discussing the national importance of General Scott's Cement Process. The Chairman said that a meeting was held at Stafford-house in 1872, and Scott's Sewage Company was formed a year afterwards. Ever since then the directors had been trying to show to the world that General Scott's process was a right one. It had been tried at Burnley, and the time had come when it should be shown how the process worked there. When he himself went into the company it was not with the notion of making 5 or 10 per cent., but with the idea that it was a national work. Sir Henry Cole showed specimens of the filthy sewage of Burnley, which he said, was about of the same description as that of other towns; but by having lime put into it in proper quantities, became clarified. With a sufficient quantity of lime, and with proper care, the water became quite clear. The deposit contained what was necessary for making cement. If cement were to be made either in St. James's-park or at Burnley there must be a certain proportion of lime, of silica, and of alumina. In General Scott's process were these ingredients for cement, and according to the quantity of lime used was the Portland or Roman cement, or agricultural lime produced. All sewage had so much organic matter in it that it would burn of itself, and produce a clinker that any cement manufacturer's eye would be charmed with as a proper material to be converted into cement. That was now going on every day at Burnley. Towns must learn to pay to be clean; this company could produce a clear effluent; and if a town would pay for it the question was solved how to prevent the pollution of rivers. The system is particularly applicable to London, which place had a monopoly for pouring filth into the Thames. To make London clean in its water would not cost sixpence per head of the population. After a discussion, in which Mr. Thompson, of Manchester (who expressed approval of the process), Mr. Bryan, the engineer, Dr. Siemens (who thought the process suitable for the Thames), Mr. C. B. Denison, Mr. W. M. Wilkinson, and Mr. Alderman Scott, of Burnley, took part, the Chairman was thanked for presiding, and the proceedings terminated.

TECHNICAL EDUCATION.

The following is the report of the Executive Committee to the General Committee of certain of the Livery Companies of London, which has been for some time engaged in preparing a scheme for the establishment in London of an Institution for the Technical Training of Artisans:—

1. Your Executive Committee beg leave to give the following account of the steps that they have taken, and to report the recommendations which they offer for your consideration.

2. Looking at the importance of the subject confided to them, the Executive Committee deemed it would be well for their assistance in preparing recommendations to the General Committee, to obtain from men of high standing and of varied pursuits their views upon technical education, and on the 28th July, 1877, they caused to be sent a letter to a number of gentlemen whom they had selected on account of their knowledge of pure science, their acquaintance with scientific education and with technical examination, their position as employers of labour, or by reason of other qualifications rendering them competent to give valuable advice, and, as the result, the Executive Committee are glad to say, they have received reports from the undermentioned gentlemen:—Sir W. G. Armstrong, C.B., F.R.S.; G. C. T. Bartley; Lieut.-Col. Donnelly, R.E.; Capt. Douglas Galton, C.B., F.R.S.; Prof. T. H. Huxley, F.R.S.; and H. Trueman Wood, B.A.

3. Prints of the reports have for some time past been in the hands of the members of the General Committee.

4. Having received these reports, the Executive Committee thought it would facilitate the study of them if they were summarised and collated. This has been done, and a print of the summary is given,

5. The object which the livery companies have in view is the improvement of the technical knowledge of those engaged in the manufactures of this country, whether employed as workmen, managers or foremen, or as principals.

6. It appears to your Executive Committee that except in some very special instances, such as the introduction of a new industry or the revival of an old one, the companies should not endeavour to effect this improvement by teaching the workman to be more expert in his handicraft; as in their judgment this form of improvement is one which must be derived from greater assiduity in the workshop, and from longer practice therein, and they therefore are of opinion that, except in special cases, it would be unwise to establish any place for teaching the actual carrying out of the different trades—that is to say, a place in the nature of a model manufactory or workshop, or to provide instructors, for instance, in sawing and

planing, and in chipping and filing; but they advise that the direction to be pursued in improving technical education should be one which will give to those employed in manufactures, the knowledge of the scientific or artistic principles upon which the particular manufacture may depend. As illustrative of these views they would refer to two great industries, iron and textile fabrics. With respect to iron, it is believed it would be unwise to endeavour to improve that manufacture by instructing a puddler how to handle his tools in a superior manner, or the blast furnace-man how to manipulate his furnace; but on the other hand, your Executive Committee think it would be of great utility to give to such men (and especially to the managers of iron works) the scientific instruction which will enable them to know why it is that occasionally, in spite of manual dexterity, and in spite of attention, the puddle-bar is bad, or the pig iron is unsaleable, except at a reduced price. The application of the science of chemistry to the manufacture of iron affords this knowledge—instructed in such application, the iron master, his manager, his foremen, and even his workmen will know how, when varying fuel or varying mineral or fluxes are brought under treatment to suit the particular foreign (and commonly noxious) matters which are found accompanying the fuel, the flux or the ore, and how, notwithstanding these admixtures, to succeed in producing an excellent quality of iron. Similarly, as regards the manufacture of textile fabrics. While, in the opinion of your Executive Committee, it would be unwise to follow the plan which has been pursued in some places upon the Continent, of endeavouring to give extra dexterity to the operative by establishing model manufactories or workshops, it would be most wise to give the chemical knowledge and the artistic instruction which would enable the worker to grapple with differences in the quality of water, differences in the qualities of dyes and of the materials to be dyed, and would likewise secure the designer from violations of the canons of good taste, and your Executive Committee are glad to say that in the foregoing views they are, without exception, fully supported by the reports of those who have kindly assisted them with their advice.

7. Assuming that you should concur with your Executive Committee as to the direction to be taken for improving technical knowledgo, the next question is, what should be the plan to be pursued and what the magnitude of the outlay to be embarked upon in the first instance; and here your Executive Committee would call particular attention to the advice so strongly given by Sir William Armstrong and others to proceed by steps and not to commence upon an extravagant scale. This advice appears to your Executive Committee to be sound and practical, and they recommend, therefore, that in the outset too much should not be attempted, but that at the same time the plan should be so framed as to admit of gradual development.

8. In the judgment of your Executive Committee the desired ends can best be attained by means of a central institution and by means of local trade schools. Your committee desire to recommend, as soon as funds sufficient for that purpose are available, the establishment in some convenient locality in London, of a central institution for more advanced instruction, wherein no one should be received who did not show on examination that he had acquired in some of the existing science and art schools or otherwise a sufficient knowledge of science and art, so as to enable him to profit by the instruction to be given in this central institution in their application to manufactures. This institution would supply competent teachers for the local trade schools, and year by year there would also go forth from it a supply of superior workmen, foremen, managers, and principals of manufactories. With regard to the trade schools, foremen, workmen, apprentices, and others, who could show that they had already received sufficient elementary instruction in the principles of science and art to follow the teaching in these schools, should be taught the application of science and art to particular trades, by teachers having a competent knowledge of the actual practice of those trades, as well as of the scientific and artistic principles to be applied to them. Such schools your Executive Committee do not recommend to be founded in the first instance, at all events, by the livery companies, as it is believed it would be well to trust to residents in the localities where these schools are most needed to establish them, and your committee think that the object of the livery companies may best be attained by affording aid to such local effort, but should the assistance thus given not form a sufficient inducement to secure the establishment of suitable trade schools, your Executive Committee would recommend in such event that the establishment of at least two such schools, to serve as models for others, should be undertaken by the companies. Your committee are of opinion that the assistance to, or establishment of, such trade schools should not be deferred till after the establishment of the central institution.

9. Examinations would be periodically held in the central institution as well as in the trade schools, prizes would be awarded, and certificates of merit would be issued in connection therewith.

10. Your Executive Committee do not recommend that buildings should be erected at the very outset for the central institution. In their judgment the value of such an institution must mainly depend upon the energy and ability of the professors and others concerned in its management and direction, and not upon the imposing character of the buildings in which their labours may be carried on, and certainly much might be done in temporary buildings (adapted at some expense, if need be, for the purposes immediately required), to get together the nucleus of a staff of professors to conduct the operations of the central college, and also to give advice and help in reference to the trade schools above indicated. On the other hand, your Executive Committee cannot but think that the livery companies could desire to see their central technical institution provided at no distant time with a building of adequate proportions and convenience, wherein its professors and pupils may work under the most favourable conditions—regard being had primarily—as Professor Huxley suggests—rather to what is wanted in the inside than what will look well from the outside; whilst the site to be chosen should admit, in their opinion, of considerable addition to the building first erected. Such a site your Executive Committee trust will be provided in whole or in part by the generous help of the Corporation of the City of London, and the capital outlay for building, which need not exceed £30,000 or £35,000 in the first instance, will doubtless be provided at the proper time by the liberality of the livery companies. Attaching great, although not prime, importance to the provision of permanent buildings, with apparatus, laboratories, and other accommodation necessary for the perfected curriculum of practice and study to be pnrsued in the central institution, your Executive Committee recommend that this ideal should be kept in view from the very first, and that no time or opportunity should be lost in providing a suitable site for such a permanent building.

11. Your Executive Committee are advised that the course of studies to be pursued at the central institution should embrace:—Applied physics, with a professor, a demonstrator, and an assistant; applied chemistry, also with a professor, a demonstrator, and an assistant; and applied mechanics, with a professor, a demonstrator for mathematics, a demonstrator for mechanical drawing, and an assistant; and also that there should be an applied art department, with a superintendent or professor, and assistants for the necessary classes. The salaries, and a proper amount for general expenses, would be covered by the sum of £10,000 a year, allowing £1,000 for the rent of temporary buildings; but as distinguished from annual expenditure there would in the outset be required a

quasi-capital ontlay to adapt the bnildings for the purposes intended, and also to purchase the fittings of the laboratories, lecture-rooms, class-rooms, the books for the library, the illustrative models, and other matters. Your Executive Committee are of opinion it wonld not be safe to allow less than £3,000 for this outlay.

12. With this first outlay and annual expenditnre, it is believed that the central institution would be competent to instruct a large number of regular students, and in addition would, it is hoped, be able to undertake other work of almost cqual importance—as, for instance, the delivery of evening lectures relating to applied science and art; and holding of evening classes in relation thereto; the discussion of discoveries of importance in trade; and generally the promotion of the application of science and art to industry.

13. Your Executive Committee further recommend that an additional sum of, say, £10,000 per annum, should be devoted towards providing exhibitions for meritorious students, tenable at the central institution; assisting technical clsssccs already established, such as those at King's College and elsewhere; aiding the efforts which are being made or may hereafter be made at the seats of special manufacture in furtherance of technical education, including more especially, as already mentioned, grants towards the cost of buildings and laboratories for encouraging the establishment of trade schools in London and in the provincial centres of industry, payments on results in connection with the system of technological examinations; and likewise in providing prizcs, premiums, and apprentice fees. Considering the great importance of the trade schools, your committee recommend that not less than £3,000, out of the sum of £10,000 above-mentioned should be appropriated for the assistance to or establishment of such trade schools. There would be moreover an expenditure of £1,500, say, for "administration." Your committee bclieve that such a commencement of the proposed undertaking as that rccommended would be based on a practical working scale, sufficient to do great good, while at the same time it would enable the livery companies to ascertain by actual expcrience the modifications which might advantageously be made hereafter; and while hoping and believing that the efforts of the livery companies to improve technical education will produce most important results—results worthy of the bodies to whom they would be due—your Executive Committee repeat their recommendation that at first it will be in every way desirable to proceed with caution, and not to commit the companies to a scheme which experience might prove to have been based upon erroneous views.

14. Having regard to the foregoing recommendations, the committee trust that the livery companies of London, desirous of improving technical education, will see fit to contribute a sum of not less than £20,000 per annum for such object, as from 1st January last, in order that the undertaking may be commenced forthwith on an adequte and satisfactory basis.

15. For the carrying out of the foregoing suggestions, a governing body will be required, upon whose administration the success of the undertaking will greatly depend. Your Executive Committee have prepared and inserted in Appendix D, a draft constitution of a governing body calculated, as they think, to fairly represent those from whom the undertaking will derive its support, and at the same time, to form a good working body.

16. Annexed is a statement of the sums conditionally promised by certain of the livery companies, and your Executive Committee have reason to believe that, in some cases, these sums may receive early augmentation. Several other companies have also promised assistance, without yet defining the precise amount:—

	£	s.	d.
Mercers' Company	£2,000	0	0
Drapers' Company	2,000	0	0
Fishmongers' Company	2,000	0	0
Goldsmiths' Company	2,000	0	0
Sadlers' Company	300	0	0
Ironmongers' Company	300	0	0
Clothworkers' Company	2,000	0	0
Armourers' and Brasiers' Company..	525	0	0
Cordwainers' Company	250	0	0
Coopers' Company	105	0	0
Plaisterers' Company..	52	10	0
Needle Makers' Company	50	0	0
	£11,582	10	0

The report is signed by Selborne, chairman, Mercers' Company; F. J. Bramwell, deputy chairman, Prime Warden of Goldsmiths' Company; Joseph Beck, Corporation of London; George F. Aston, Master, Mercers' Company; W. H. Dalton and Henry Trower, Drapers' Company; John Samuel, Prime Warden, Fishmongers' Company; Walter C. Venning, Fishmongers' Company; George Matthey, Goldsmiths' Company; Robert B. Woodd, Master, Salters' Company; H. Rokeby Price, Master, Ironmongers' Company; Sydney H. Waterlow and James Wyld, Clothworkers' Company; Charles J. Shoppee, Master, Armourers' and Brasiers' Company; William Heath, Cordwainers' Company; Samuel Morton Hubert, Plaisterers' Company.

At the end of the report are four appendices. The first gives the circular letter addressed to the framers of separate reports; the second is a summary of the propositions made by the writers of these reports; the third is an estimate of the cost of the institution; and the fourth gives the proposed governing body as follows:—

The City and Guilds of London Institute, for the Advancement of Technical Education.

The government to be vested in the following:—

The President and (not exceeding 12) Vice-Presidents to be liverymen of London.

(*a.*) The Board of Governors, as the supreme governing body.

(*b.*) The Council.

(*c.*) The Executive Committee (of Council).

(*a.*) The Board of "Governors" to consist of liverymen of London, viz.:—

The President and Vice-Presidents (*ex-officio*) elected by the Board.

The Master, Prime Warden, other appointed member, of each of the livery companies of London, contributing £50 per annum, or making a donation of £500 to the general funds of the institute, or for any special object approved by the Council, and an additional representative for every further sum of £100 per annum, or donation of £2,000.

Any liverymen of London contributing £50 per annum, or making a donation of £500 to the general funds of the institute.

The Lord Mayor, Aldermen, and Recorder of the City of London (*ex-officio*).

Twelve representatives of the Court of Common Council, to be chosen by that Court.

b. The Council to consist of—

1. The Lord Mayor (*ex-officio*).

2. The President and Treasurer (*ex-officio*), the Master, Prime Warden, or other appointed member of each of the livery companies contributing £500 per annum and upwards, or a donation of £10,000 to the general funds of the institute, or for any special object approved by the governors.

40. Governors annually elected by the Board of Governors, a moiety thereof at the least to be members of companies contributing less than £500 per annum, if there be so many eligible. A governor nominated by each livery company for each additional sum of £500 per annum, or each additional donation of £10,000 to the general funds of the institute, or for any special object approved by the Council.

4. Governors nominated by the Court of Common Council, or such an increased number as the Court may be entitled to nominate under the preceding rules if it were a livery company. Governors nominated by the president.

Note.—The Council to elect their own chairman annually from their own body.

(*c.*) The Executive Committee to consist of—

1. The Lord Mayor (*ex-officio*).

3. The President, Chairman of Council, and Treasurer (*ex-officio*).

20. Members of Council elected annually by themselves from their own body, one fourth thereof at the least to be members of companies contributing less than £1,000 per annum. A member of Council nominated by each livery company in respect of each contribution of £1,000 per annum, and in respect of each donation of £20,000 to the general funds of the institute or for any special object approved by the Council.

2. Members of Council nominated by Court of Common Council, or such an increased number as the Court may be entitled to nominate under the preceding rules if it were a livery company. Members of Council nominated by President.

Note.—The Executive Committee to select a Chairman annually from their own body, and to have power to appoint such sub-committees as may be deemed necessary.

The Treasurer to be an honorary officer chosen (subject to re-election annually) by the Board of Governors out of their own body.

Two or more honorary Secretaries to be chosen annually by the Council.

The Board of Governors to meet once a year, at a time to be fixed by themselves, and whenever summoned by the president or by the order of the Council or Executive Committee. In the absence of the President, the Board of Governors to be presided over by the Chairman of Council, and in his absence by the Chairman of the Executive Committee, and failing him, by a member of the Executive Committee elected by the meeting.

The Council to hold quarterly meetings.

The institute to be incorporated under the powers of the Board of Trade. (Vide 23rd Sect. of "The Companies' Act, 1867.")

AGRICULTURE IN INDIA.

Dr. Forbes Watson writes:—"I regret that I was unable to be present on the occasion of the reading of Mr. Danvers's very valuable paper on 'Agriculture in India,' and I take this opportunity of enclosing the following extract from a note of mine on the establishment of agricultural farms in India, which I am in hopes may still prove of interest."

"The Government of India has the strongest possible inducements for trying every method of improving native agriculture, and among these the establishment of agricultural farms appears to be one of the most important. The yield per acre, of almost every description of agricultural produce, is less in India than in other countries in a more advanced state of civilisation. The full importance of this inferiority can only be realised when it is kept in mind that the population is there more densely packed than anywhere else, China, perhaps, excepted; so that, if the cultivated area be divided among the population, hardly more than one acre will fall to the share of each inhabitant, whilst even in the United Kingdom, with all its large importations of the agricultural produce of other countries, the share per inhabitant would be very nearly one acre and a half. The average crop of wheat in England, moreover, must be taken at not less than 1,800 lbs. per acre, whilst in India it seldom exceeds 1,200 lbs., and frequently falls to 1,000 and 700 lbs. per acre, and in some backward provinces the returns indicate a yield of hardly more than 400 lbs. The difference is even more striking in some of the commercial staples. Cotton yields in India, on the average, only from 60 to 70 lbs. of clean fibre per acre, as against from 250 to 300 lbs. in the United States, and as much or more in Egypt. Such is the case at present, but agriculture is now almost everywhere in a rapidly advancing condition, and the relative inferiority of India is becoming greater and greater, and threatens to endanger the further development of staples in which she enjoys as yet a pre-eminence. Thus the cultivation of sugar-cane and the extraction of sugar has considerably advanced in most of the colonies, but the formerly considerable export of sugar from Bengal has fallen off to a mere fraction of what it has been. There is no staple which may not be threatened in the same manner. America is vigorously trying to develop the growth and production of indigo and jute. The Burmese rice has to encounter competition from Java, from Siam, and from Cochin China. India's monopoly of opium is attacked from both without and within, by expanding cultivation, and by a blight threatening the Indian crops. Nothing but improved agriculture can preserve and develop the position already acquired by India in regard to these staples. The development of agriculture as bearing on the food resources of the country is important from a twofold reason. It increases the area which can be devoted to industrial crops, and it increases the certainty of the yearly food crop; it being an established fact that not merely extended irrigation, but also all improvements in cultivation increases the resisting power of crops against the effects of unpropitious seasons, like other causes of scarcity.

"It is, therefore, abundantly evident that no Government has ever had more inducements for promoting agriculture than the Government of India. It remains to inquire what are the chances of success to such an enterprise. It is commonly held that agriculture in India is so entirely a master of tradition, that it is hopeless to attempt the introduction of changes really affecting the bulk of the community. To meet this argument, it is obviously irrelevant to adduce the instances of indigo, coffee and tea, as these have been all developed by and still rely almost exclusively on European enterprise. But independently of the above examples, instances of important agricultural changes can be brought forward which have affected the whole native community. Tobacco supplies a striking example. As appears from the Emperor Jehangir's memoirs, it must have been introduced into India, probably by Europeans, early in the seventeenth century; and already in the eighteenth century there was hardly any village without its tobacco plot. Maize, a plant of American origin, is now extensively cultivated in Northern India, and forms the staple food of the population in some of the more hilly parts, such as Nepaul, parts of Chota Nagpore, and Bhangulpore, as also in the hills of the Punjaub. Potatoes are even of a more recent introduction, and are not only largely grown in common with other European vegetables for the use of Europeans all over India, but already from an important crop for native use in some parts, for instance in South Eastern Tirhoot. An instance of the rapid extension of a purely Indian staple is afforded by the development of the cultivation of jute. Similar instances of change might be multiplied, but enough has been said to dispose the pretended impossibility of changing the course of native agriculture. It would be difficult to maintain that such a charge could not be guided and accelerated by judicious action on the part of the Government.

"There is, however, a widespread opinion that even if beneficial action be possible, the obstacles to improvement which have to be encountered in India are of an exceptionally unmanageable nature, and such as to render all hope of important reforms a very remote one. It is very difficult to bring conclusive evidence either for or against this opinion from Indian experience, for

the simple reason that whatever has hitherto been done in India in the matter of agricultural improvement has been done so fitfully and unsystematically that it affords no clue to what may result from a better planned action. But the same difficulties as those met in India have obstructed agricultural reform in many other countries, and an extraordinary amount of time and persistent effort has been everywhere necessary to overcome the inertia of the agricultural classes. As a matter of fact, to this day reports may be read from Spain, from Italy, Austria, Russia, and Eastern Europe in general, referring to the state of agriculture in almost the same terms as those used by various official and unofficial gentlemen consulted in Bengal with regard to the establishment of experimental farms. Attachment to tradition, want of enterprise, want of capital, smallness of farms,* and other obstacles to improvement had to be encountered in most countries; and it might also be asserted that almost every instance mentioned in proving the obtuseness of the Indian ryot might be matched by European and even English parallels. If the rate of progress in Europe is at the present time more rapid than any which can be hoped for in India within the present generation, it is because the movement for agricultural improvement, still struggling for its mere existence in India, has in Europe set in a century back, though it has only lasted in full force since the conclusion of the peace in 1815. It is in the nature of progress to go on in an accelerated ratio, each successful venture encouraging others. The great preliminary difficulty is to make the idea of beneficial change, improvement, and progress take root among the agricultural classes. This may be the task of a generation, but, if once effected, agricultural progress will enlist such an amount of spontaneous force on its behalf that its rapid advance in the future is certain. The spread of education in India, even if mostly without any direct bearing on agriculture, will have the beneficial effect of making the minds of people more receptive of change; but time is necessary to bring this influence into action. Time and persistency are the main conditions of success in agricultural reform, and cannot be replaced by any amount of sudden effort. It is time and persistency, which the cause has never yet had in India, that is wanted. Agricultural improvements relegated amongst the minor duties of land revenue officers have never received special and continuous attention. Whenever any start had been made in this respect by some collector or governor, it hardly ever occurred that the matter was taken up by his successor, and thus the attempt only went to increase the long list of individual failures. If, however, agricultural establishments on no larger scale than those now proposed had been organised 25 years, although the effect on the country at large might have still remained very small, there would now be existing all the germs of a rapid development; scientific agriculture would have already been acclimatised in India, and there would not be that dearth of exact information or of suitable agency which, now and for years to come, will render all important progress slow and difficult.

"A satisfactory feature in the case is the thorough sense which has at length come to be entertained of all the difficulties standing in the way of agricultural improvements and of preliminary conditions for successful action. It is at length recognised that as yet Europeans have next to nothing to teach the natives in matters of agriculture except general ideas; that before Government attempts to direct the native agriculturist to better methods, those methods must be discovered; that wholesome importations of English methods, tools, and machinery, and of ready-made scientific rules, can meet with nothing but failure; and that a long series of experiments, conducted by specially qualified men, is necessary, in order to find out the specific manner in which the general scientific ideas or empirical results of European agriculture can be applied to the vastly different conditions of soil and climate in India, and in order to realise what improvements are suited to the economical position of an Indian ryot. There is no such thing in existence as a science of agriculture which can afford, without further trouble, infallible guidance to the Indian cultivation. It is not abstract science which is wanted, but men with habits of scientific observation of agricultural phenomena. Such men, versed in the principles of the sciences referring to vegetation, and brought into contact with actual agriculture, as carried on under Indian conditions, will in time, by patient investigation, discover rules for practical guidance, based on scientific principles, and suited to Indian conditions. The advantage of science is not that it would enable them to dispense with Indian experience, but that it will supply them with better methods of observation, and enable them to profit more quickly by experience, and to derive from it more practical conclusions than could be derived in the same time by men not possessed of previous scientific training.

"Thus far the movement for agricultural improvement is barely at its commencement, and nothing could be more dangerous to it than extravagant expectations of its immediate influence on the state of Indian agriculture. The first few years can hardly be expected to produce any other result than to educate and train the officers in charge of the experimental farms. But it can hardly be doubted that, after this preliminary period, really useful results will be obtained, and that through them there will gradually accumulate specific knowledge of the means for further advancement, based upon actual Indian experience, and not upon inapplicable English precedents or vague scientific abstractions. It is at that stage that another condition of agricultural progress will assume great practical importance, viz., the establishment of some organisation for the purpose of disseminating and popularising among the bulk of the people the knowledge that will have been acquired. On the success in this endeavour will depend the economical importance of the information and the degree in which it will influence the country at large.

"It may be useful, in conclusion, to give a short view of the organisation existing on the continent for the futherance of agriculture.

"As regards agricultural education, there exist—

"Agricultural academies, in which the highest possible teaching is given, embracing the whole range of sciences connected with agriculture.

"Practical agricultural schools for farmers' sons, such as the French *fermes écoles*, in which the proprietor of a well-managed estate receives a subvention from the Government, and takes in pupils of the farmer class, who receive in addition to their practical occupation on the estate a certain amount of theoretic instruction also.

"Special schools for forestry, horticulture, vinology, pomology; as also veterinary schools.

"Agricultural professorships attached to universities and colleges.

"Agricultural and horticultural teaching frequently connected with the elementary schools, and provided with suitable gardens and plots of land.

"Itinerant lectures on agriculture, maintained or subventionised by Government or by private associations.

"The science of agriculture is advanced by numerous "experimental stations" of a scientific character and in charge of a scientific man; by experimental farms of a more practical character in charge of a practical agri-

* One difficulty which seems to be considered as peculiar to Bengal, viz., the fact that the holding of a ryot already small in itself, is rendered even more unsuitable for improved agriculture by consisting of several separate plots, situated in different parts of the village, had to be encountered in other countries as well. In Prussia and elsewhere, in continuation of the Revenue Survey Operations (cadastre) Commissions have been appointed for the purpose of consolidating the farms by mutual exchange of the outlying plots. This process called "commassation" has been carried out on a large scale with very beneficial effects.

culturist; whilst cattle breeding is more particularly attended to in special sheep and cattle farms.

"A broad basis of practical usefulness is given to the whole system by the existence of powerful agricultural associations, frequently embracing a considerable proportion of the practical agriculturists and farmers. Their meetings, their journals, the exhibitions and shows organised by them, are the most powerful means for introducing rapidly into practice all new ideas and suggestions.

"Thus there exists in Europe an extraordinary amount of agency available for the universal introduction of agricultural improvements, side by side with establishments for the further scientific development of agriculture. No time should be lost in trying to provide India with a nucleus at least, of a similar organisation, having in view both sides of the question—the development of new agricultural methods, and their rapid dissemination, without which success in the first part of the task will only remain a sterile scientific acquisition."

NATIONAL WATER SUPPLY.

The following unopposed motion by the Marquis of Stafford was granted by the Government on the 23rd May. It has an important bearing on the question of the national water supply:—

Return ordered, showing the means by which drinkable water is supplied to every urban sanitary district in England and Wales, such means being provided by public or private arrangements. The return should state for each district,—

1. The name and population according to the census of 1871.
2. The source from which water is supplied.
3. The arrangements made for the supply, by reservoir, wells (artesian or otherwise), rivers (if filtered or not), or any other arrangements.
4. Amount of daily supply, and whether or not the supply is sufficient.
5. Whether the supply is constant or not, and the quantity used daily.
6. The rateable value of the district.
7. The capital cost of the permanent works, if any.
8. The annual payment for principal and interest on money borrowed for the works.
9. The average annual cost of maintaining the works.
10. The annual amount of water rates and rents, if any.
11. The Act of Parliament or other authority under which the works have been executed.
12. What improvements, if any, are considered necessary.

CORRESPONDENCE.

DIET.

Will you allow us, as the largest manufacturers of whole-meal bread in London, to state, in reply to Dr. Wyld's communication of last Saturday:—"It is reported to me that much injury has been done by some of these whole-wheat breads, and that, on analysis, arsenic has been found, derived from the hydrochloric acid used," that, whilst believing this may possibly be the case with some of the cheaper whole-meal bread manufactured, we hold a guarantee from our manufacturing druggist, assuring us of the absolute purity and freedom from arsenic of the acid used by us.

We may remind your readers that the mixture of hydrochloric acid and carbonate of soda, used to generate gas to lighten the whole-meal bread, leaves as a result the common table salt, which is, of course, perfectly harmless. NEVILL AND SON.

60, Bishopsgate-street Within, E.C., and 3, Albert-mansions, Victoria-street, S.W., London, May 29, 1878.

AGRICULTURE IN INDIA.

I have read with much pleasure Mr. Andrew Cassels' valuable letter published in your last issue, and trust you will allow me to endorse the views he has so well put towards the end of it as to the necessity for a methodical treatment of the important subject of Indian agriculture. To begin at the beginning of your subject is as necessary in agriculture as in anything else. Are your land tenures as good as you can make them? Is the state of agriculture owing to the poverty of the people? Is the general management of the lands of the country such as is most favourable to good agriculture? Is the state of agriculture owing to causes beyond the control of the farmers; and if so, how can the Government modify these causes? As Mr. Cassels well says, "It seems to me that the condition" (and circumstances, he might have added) "of the people is to be chiefly looked to in any inquiries we make into the state of agriculture of a country." If the Society again takes up this important subject, this is the point to which its attention should be directed. It is of no use to spend an evening, or any number of evenings, in scratching at the back of the tree; the improvement must come from the root. The conditions at the bottom are bad, and are not to be rectified by a thin plaistering of English implements and agricultural chemistry.

ROBERT H. ELLIOT.

38, Park-lane, W.

GENERAL NOTES.

Sewage Statistics.—At a recent meeting of the Institution of Surveyors, Mr. R. W. Peregrine Birch read a paper on the use of sewage by farmers. Mr. Birch has collected a considerable quantity of statistics on this subject, from which the following conclusions are drawn:—1st. That there are upwards of 100 owners and occupiers of land in Great Britain who use sewage for the sake alone of what they can get out of it by agricultural means. 2nd. That of this number more than sixty are tenant farmers who continue to use it although they have, annually at least, the option of ceasing to do so. 3rd. That of the latter number about five-sixths, and of the total number about three-fourths, actually pay money for the use of the sewage, either in the form of out-fall rent, unquestionably increase of land rent, or the price of occasional dressings. Nearly 4 000 acres of sewage land have been referred to, and these are in the hands of more than a hundred distinct occupiers. These occupiers may be divided into three classes:—Those who have to cleanse a certain quantity of sewage on a certain area of land; those who may take, or leave alone, as much of a town's sewage as they please; and those who may take, or leave alone, what sewage can be spared by others having a prior right. The first class occupies 1,670 acres of sewaged land, and deals with the sewage of twenty distinct sanitary districts, or a population of about 200,000 on as many as twenty-one different farms.

Water in India.—The Queen's birthday was made the occasion for opening the Dacca Waterworks. These works are a princely gift from the Nawab Abdul Ghani, a most enlightened and philanthropic native nobleman, in order to commemorate the recovery of the Prince of Wales from his dangerous illness in 1872. Lord Northbrook laid the foundation stone. The Nawab and his son together have given 150,000 rupees for the construction. Dacca has for a long time possessed a very evil reputation for cholera and other diseases produced by bad water; it is difficult, therefore, adequately to measure the benefit conferred upon the poorer classes by this munificent boon. The absence of pure water is sufficient to account for almost every description of tropical illness existing in India. If other native princes would follow this noble example and devote their surplus wealth to the mitigation of the miseries of life induced by the climate, instead of lavishing it on mere idle ostentation,

as most of them are in the habit of doing, Indian towns might be rendered in a comparatively short time almost healthy. No more remarkable example can be given than the present healthy condition of Calcutta, which entirely dates from the time when the inestimable blessing was conferred upon it of a pure water supply.—*Times.*

Parchment Cotton for Mixing with Wool.—An American paper gives an account of the production and use of parchmented cotton as a substitute for wool. The raw cotton, well cleaned, is left for twenty-four hours in a solution of one part concentrated sulphuric acid, one part sulphate of glycerine, and three parts water, at a temperature of sixty-three and a-half degrees, Fah. It is then wrung between glass rollers, until test paper no longer reddens. After drying, the fibres are found to have acquired many of the qualities of sheep's wool, and for using this cotton for spinning, weaving, or dyeing, it has only to be wrapped in felt. When fabrics are made exclusively with the transformed material, and finally have been animalised in the usual way by milk, ammonia, oil, and lime, the fabric can scarcely, it is said, be distinguished from genuine woollen goods, except by the smell given off in burning them, since the lanified smells just like the natural cotton. The properties thus acquired by the cotton, will, it is thought, tend to supesede the ingredients hitherto used for producing half-woollen goods. In regard to cotton parchmented as a substitute for linen, cotton yarn which has been steeped for twenty-four hours in a mixture of two parts concentrated sulphuric acid, and three parts water at sixty-three and a half degrees, Fah. is pressed and dried as above; it not only thus acquires the property of linen yarn, but is also stronger than the latter. The difference in price, especially in fine numbers, such as are used for cambrics, is, it is alleged, much in favour of the new process.

Egypt and Africa.—An item of news from Egpyt is suggestive of an important future. A circular from a house in the cotton trade informs us that the native dealers are holding back the forwarding of supplies in consequence of awaiting a reduction of tariff announced by the railways communicating with the interior of Africa. This points to a larger area of cotton cultivation, and to the practical utilisation of the great masses of agricultural land teeming with population which the Khedive has added to Egypt, or rather made his own, by his operations within the last five years towards Darfour. The land-hunger of the Pharaohs, as commemorated in the action of Joseph as financial minister during the seven years' famine recorded in the Scriptures, seems as hereditary and continuous in the rulers of Egypt as does the programme laid down in the will of Peter the Great in the policy of Russia. But to the bare scratching of the earth by a starving peasant of the Pharaoh's period, the Khedive has added the force, the appliances, the instruction, the tools, the implements, and the machinery of modern civilisation.—*British Mercantile Gazette.*

Imported Straw.—Cheap newspapers have enhanced the value of land by raising the price of straw, the major part of which is now consumed for paper-making. Straw that was formerly 21s. is now £2 10s. the ton. For economy's sake, the 6,000 horses of the London General Omnibus Company are bedded in sawdust. The Dutch farmers are sending over straw by steamers in pressed bundles of 2 cwt. in square bales of about 3 ft. 6 in. by 2 ft. 6 in. It may be seen passing up the Medway by barge loads to Maidstone, for the paper mills, to which it is being supplied at 40s. per ton of 11 cwt.; it gives an advantage to one mill, which consumes 200 tons per week, of £4,000 per annum. The Spanish Government has imposed an import duty of £20 per ton on paper, which is about 2½d. per pound on what is now from 4d. to 6d. This is to protect Spanish makers, in other words, to compel newspaper readers and students of books to pay a tax to them for making bad paper.

The cultivation of the opium poppy is likely to become established in Eastern Africa. Seeds of the best kinds have been imported from Malwa into Mozambique, where 50,000 acres of uncultivated State land have been granted to a company, with a capital of £178,000, for the purpose of cultivating and trading in opium. Besides the grant of land, the company also receives from the State the right for twelve years to export opium free of duty.

NOTICES.

THE LIBRARY.

The following works have been presented to the Library:—

A Manual of Microscopic Mounting, with Notes on the Collection and Examination of Objects, by John H. Martin (London: J. and A. Churchill, 1878.) Presented by the Author.

History of the Life-Boat and its Work, by Richard Lewis (London: Macmillan and Co., 1874.) Presented by the Author.

Imperial College of Engineering (Kobu-dai-Gakko), Tokei. Reports by the Principal and Professors, 1873-7 (Tokei: 1877) and Calendar, session 1877-8 (Tokei: 1877.) Presented by Henry Dyer, Principal of the College.

The Quarterly Journal of the Amateur Mechanical Society. Vols. 1 and 2. (London: Trübner and Co., 1871-7.) Presented by the Society.

Trinity House, London. Fog Signals. Part 2. (London: 1878.)

The following pamphlets have also been presented for the Library:—

The Dangers of Sewer Gas in our Dwellings, by W. Copley Woodhead, M.R.C.S. (Leeds: 1878.) Presented by the Author.

Report of the Health of Liverpool during the year 1877, by J. Stopford Taylor, M.D. (Liverpool: 1878.)

MEETINGS FOR THE ENSUING WEEK.

Tues....Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. Dallinger, "Researches in Minute and Low Forms of Life." (Lecture II.)
Photographic, 5a, Pall-mall East, S.W., 8 p.m. 1. Mr. J. R. Johnson, "Alizarine in Pigment Printing." 2. Mr. T. Bolas, "Gelatine Pigment Printing." 3. Mr. L. Warnerke, "The Phenomena of Solarization."
Anthropological Institution, 4, St. Martin's-place, W.C., 8 p.m. 1. Dr. John Beddoe, "The Bulgarians." 2. Miss A. W. Buckland, "The Use of Stimulants among Savage and Primitive Peoples." 3. Mr. Sanderson, "Polygamous Marriage in South Africa."

Wed. ...Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.
Royal Botanic, Inner Circle, Regent's-park, N.W., 2 p.m. Summer Exhibition.

Thur....Aeronautical Society (at the House of the Society of Arts), 8 p.m. General Meeting.
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Guthrie, "Molecular Physics—Solids" (Lecture III.)
Royal Historical, 11, Chandos-street, W., 8 p.m. 1. Mr. Hyde Clarke, "The Settlement of Britain by the English Races." 2. Dr. Altschul. "History and the Drama." 3. Mr. Henry H. Howarth, "The Columban Clergy in Scotland and Ireland."
Mathematical, 22, Albemarle-street, W., 8 p.m. 1. Mr. Halphen, "The Characteristics of Systems of Conics." 2. Mr. S. Roberts, "The Expression of Certain Numbers as Sums of Two Square Integers by Continued Fractions." 3. Mr. C. J. Monro, "Flexure of Spaces." 4. Mr. H. McColl, "The Calculus of Equivalent Statements" 5. Mr. J. J. Walker, "A Method in the Analysis of Plane Curves, and in the Inflexion-Tangential Curve." 6. Mr. R. Rawson, "A New Method of Finding Differential Resolvents of Algebraical Equations."

Fri.......Royal United Service Institution, Whitehall-yard, S.W., 3 p.m. Major-General Sir Frederick Goldsmid, "Communications with British India under Possible Contingencies."
Royal Institution, Albemarle-street, W., 3 p.m. Weekly Meeting. Prof. Dewar, "Liquefaction of Gases."
Astronomical, Burlington House, W., 8 p.m.
Philological, University College, W.C., 8 p.m. Mr. Frederick Wedmore, "Caliban."
Quekett Microscopical Club, University College, W.C., 8 p.m.
Royal Botanic, Inner Circle, Regent's-park, N.W., 4 p.m. Professor Bentley, "Classification, Properties, and Uses of Plants." (Lecture VI.)

Sat.......Royal Institution, Albemarle-street, W., 3 p.m. Prof. Henry Morley, "Joseph Addison."

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,334. Vol. XXVI.

FRIDAY, JUNE 14, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

ARTISAN REPORTERS AT THE PARIS EXHIBITION.

Committee of Her Majesty's Commissioners.—The Earl Spencer, K.G.; the Right Hon. Lyon Playfair, C.B., F.R.S., M.P.; Mr. Sampson S. Lloyd, M.P.; Mr. Hugh Birley, M.P.; Mr. Joseph Chamberlain, M.P.; Mr. Samuel Morley, M.P.; Mr. John Mulholland, M.P,; and Mr. Anthony J. Mundella, M.P.

Committee of the Society of Arts.—Mr. William Hawes, F.G.S., Deputy Chairman of the Council; Lieut.-Colonel Donnelly, R.E.; Mr. Henry Doulton; Mr. H. Reader Lack, Treasurer of the Society; Mr. H. Rawlinson, C.B.; Admiral Sir Erasmus Ommanney, C.B., F.R.S.; and Mr. W. H. Perkin, F.R.S.

Secretary.—Mr. P. Le Neve Foster.

The Joint Committee have held several meetings under the Presidency of Lord Spencer, at Spencer-house and at the Society of Arts; they are now in communication with the Chambers of Commerce, the Mayors of the principal seats of industry, representative artisans, and others, in order to decide upon the best method for selecting suitable reporters.

The following is the list of subscriptions already promised:—

	£	s.
Her Majesty's Commissioners for the Paris Exhibition	105	0
The Society of Arts	105	0
His Royal Highness the Prince of Wales, President of the Royal Commission ..	50	0
The Worshipful Company of Fishmongers	26	5
The Worshipful Company of Carpenters..	10	10
Earl Spencer	26	5
The Worshipful Company of Salters	10	10
The Worshipful Company of Clothworkers	100	0
The Worshipful Company of Drapers	52	10

The Bristol Chamber of Commerce held a meeting on Friday, the 7th of June inst., for the purpose of considering a communication to the Mayor of Bristol from the Secretary of the Society, with reference to the suggestion of his Royal Highness the Prince of Wales for deputing artisans to report on the industries of the Exhibition. Mr. George De Lisle Bush, the president of the Chamber, was in the chair, and there were also present the Mayor (Mr. George William Edwards), Mr. Henry T. Chamberlain (vice-president of the Chamber), Messrs. John Evans, Henry Taylor, Samuel Tanner, Charles F. Hare, Edward Robinson, J. C. Wilson (Avonside Engine Company), Albert Fry (Bristol Wagon Works Company), and P. Triggs. The Chairman read the letter to the Mayor from the Society of Arts, and, after some discussion, the following resolutions were passed unanimously:—

(1.) "That this meeting is of opinion it would be desirable to promote the object aimed at by his Royal Highness the Prince of Wales in suggesting that a select number of artisans be deputed to attend the Paris Universal Exhibition, 1878, to examine and report on the industries displayed in the Exhibition, and that the Mayor be requested to open a subscription for the purpose of defraying the expenses."

(2.) "That a public meeting of manufacturers and others interested in the subject be held at the offices of the Chamber of Commerce, on Friday, the 21st of June instant, at three o'clock, at which the Right Worshipful the Mayor be requested to preside. Any communications or subscriptions may be sent to the Secretary of the Bristol Chamber of Commerce, at the offices, St. Stephen's-street-buildings, Bristol, on or before the 20th of June instant."

At a meeting of the Birmingham Chamber of Commerce on Wednesday, the 12th inst., the question of sending skilled artisan reporters to the Paris Exhibition, as advocated by the Prince of Wales in his letter to the Joint Committee, was discussed. Several manufacturers strongly supported the proposal, and offered subscriptions, after which, on the motion of Mr. J. S. Wright, seconded by Mr. W. Wiggin, it was resolved:—"That a Committee be formed to take into further consideration the expediency of sending artisan reporters to the Paris Exhibition, to confer with the Society of Arts thereon, and, if necessary, to call another meeting on the subject to take such other steps as may deem necessary."

The Town Clerk of Edinburgh writes to say that at a meeting of the Magistrates, a Committee was appointed to correspond with the Chamber of Commerce, with a view to raising funds.

The Town Clerk of Leeds writes by direction of the Mayor to say that he has opened a subscription list with a view to the adequate representation of the special industries of the locality.

CONVERSAZIONE.

The Society's *Conversazione* is fixed to take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday, the 19th June. The cards of invitation are now in course of issue.

A Vocal Concert, consisting of glees, by the London Glee and Madrigal Union, will be given from 9 to 11 o'clock, with intervals, in the Lecture Theatre.

A Promenade Concert will be given by the Band of the Coldstream Guards in the Architectural Court, and by the Band of the Royal Marines in the North Court.

The galleries containing the Raphael Cartoons, the Sheepshanks' Collection, the William Smith Collection of water-colour drawings, the Dyce and Forster Pictures, the Collections of Paintings lent by Mr. Fuller Maitland and Lord Spencer, and the Schliemann Collection of objects from Troy will be open.

The courts and corridors of the ground floors will be open. The reception will be held in the throne room of Akbar Khan in the Architectural Court, by Mr. William Hawes, F.G.S., Deputy-Chairman, and other Members of the Council.

NATIONAL WATER SUPPLY.

The following are some of the communications brought before the Congress, held on the 21st and 22nd inst. :—

J. F. BATEMAN, F.R.S., President of the Institution of Civil Engineers.

I have the honour to acknowledge the receipt of a letter bearing your signature, from the Council of the Society of Arts, accompanied by a copy of the letter of H.R.H. the Prince of Wales on "National Water Supply."

No one is more convinced than I am of the evils arising from a bad or deficient supply of water, nor can any one appreciate more highly than I do the excellent motives which dictated the Prince's letter; but I see no way in which a large and comprehensive scheme of a national character could be made subservient to the objects his Royal Highness has in view.

How, for instance, could any scheme be combined for meeting, at the same time, the wants of a village in Northumberland and one in Cornwall, or a village in Essex and another in Merionethshire?

The large cities and towns provide for themselves and their neighbours, but many small isolated villages lie beyond the reach of such places, or the aqueducts which supply them. These small places cannot afford to incur any great expense; and as, in this commercial country, few people will be found to lay out their money on unremunerative undertakings, the only way of meeting the wants of such small places will be by the aid or contributions of philanthropic persons, who will give their money without hope of return, for the benefit of those who cannot help themselves.

Much may be done in particular districts by the adoption of such conditions as have been imposed on the Manchester Corporation, to supply, within certain limits, all urban and rural authorities who may demand water, which lie in the neighbourhood of the aqueduct from Thirlmere to Manchester, but such arrangements would not benefit distant places.

WILLIAM BENNETT, Member of the Liverpool Water Committee.

On carefully reading the letter of H.R.H. the Prince of Wales, the substance of which this Congress is met to discuss, I find that the first remark is what may be taken as the text of the whole, and reads thus:—"The supply of pure water to the population is at the present time exciting deep interest throughout the county." Pure water for the domestic use of our population is the vital point we have to discuss. I look upon the great natural water resources of the kingdom as of two kinds; one derived from springs suitable for domestic and all potable purposes, the other from rainfall which has not passed through nature's filter, and can be obtained from brooks, rivers, and other surface drainers, and also from lakes and reservoirs. Spring water has the advantage of quality, uniform temperature, freedom from poisonous compounds, and is generally so palatable as to be preferred to many intoxicating drinks. Rain water is essential to the prosperity of large manufacturing towns, for dyeing, bleaching, and numerous other uses, which require soft water in great quantity and at a small cost for their success. The mixing of these two qualities of water injures both—the spring water is made tepid and vapid, and may imbibe organic poisons producing epidemic diseases, while the rain water is spoilt for all uses where extreme softness is required; each is of so much more value when unmixed, that it would fully justify the laying of separate mains for their distribution. I attribute the high death-rate in Liverpool, amongst other causes, to the fouling of our wells, and to the mixing together of spring and surface water. The wells are receiving soakage from surfaces densely populated, and drainings from defective sewers. Deep cesspools, also charged with excrement and house filth, have been filled up with rubbish, so forcing the excrement, &c., into the pores of the rock and destroying it, as a natural filtering medium, for a depth of more than a hundred feet; amongst other evils rain water rapidly corrodes the iron pipes and acts upon lead. Liverpool is one of the towns specially named in his Royal Highness's letter, and it is one in which I have taken an active part for many years in all that pertains to sanitary arrangements. My opinion is that we have at command abundance of pure spring water to supply millions of inhabitants, for all domestic purposes, and sufficient rain water, within a reasonable distance, to supply all our manufactories, baths, washhouses, and for sanitary purposes, for all time. I look upon it as the compulsory duty of all Corporations or private companies, who obtain Acts of Parliament for the

supply of towns, "to supply pure water to the population" irrespective of trade peculiarities. I consider that it is a duty the manufacturing and trading community owe to themselves to develop the great natural resources of the kingdom, so as to adapt them to the varying specialities and wants of districts; for, as Mr. Bateman says in his evidence, Manchester wants a different water from Liverpool, and I recommend that all large towns, such as Liverpool, which have water from a large river at command, should encourage the formation of a private company for the supply of water under high pressure to be used as a motive power, the company agreeing, for the privilege of laying their pipes, to supply gratuitously at any required pressure such mains for the suppression of fires, as may be laid down by the authorities; by this course the inhabitants of large towns secure a good and wholesome water for domestic use, the manufacturers obtain the best kind of water for their "varying specialities," and by the supplying of water at a high pressure, from a costless source, a motive power can be introduced into all kinds of works and offices free from the risks of fire or explosions, and the nuisance of smoke, and in addition salt-water baths can be supplied, and fire mains kept constantly charged, and instantly adjusted to the exact pressure best suited to the site. Liverpool is now supplied from public and private wells with more than twenty-one million of gallons of spring water daily; by deeper boring, this quantity may be materially increased; and, by using water obtained solely from deep borings, the quality will be in all respects "unobjectionable for domestic use," as stated by Dr. J. Campbell Brown, the analyst employed by the Liverpool Corporation. A boring is now being made at Liverpool twenty-six inches in diameter, and one thousand feet deep, in the expectation of adding to our supply ten million gallons per week. A few similar bore-holes made in the immediate neighbourhood, it is thought, will supply pure water for domestic purposes for the next century.

A. H. BROWN, M.P.

Some time ago the question of the state of the water supply to rural districts and small towns was very forcibly brought to my notice, and from that time I have been trying to see what could be done to remedy the evils which exist. It is unnecessary for me, I think, to explain in any detail these evils. The sixth report of the Rivers Pollution Commission, the reports of the medical officers of health to their sanitary authorities, and the reports of the inspectors of the Local Government Board, prove in the fullest manner the necessity of examining into the question.

The Public Health Act contains the general provisions on this subject, and private Acts for the establishing of waterworks contain the provisions applicable to particular localities.

Now, with regard to the public supply by water companies or municipal Corporations, I feel it would be better treated by others; but I may say that, with the exception of some points to which I shall presently refer, it appears from the report of the Rivers Pollution Commission to be fair in quality and adequate in quantity, London excepted. But when there is no public supply, which is the case in many of the villages and small towns, the state of things is very bad indeed. The principal supply for the rural parts is from shallow wells and streams, which are polluted by every sort of abomination, and matter of a most disgusting origin is contained in the water used by the inhabitants. I am afraid there is too much truth in the following parody of Mrs. Hemans' lines, which Mr. Cowen gave to the House of Commons last year when speaking on this subject:—

The cottage homes of England,
How filthily they smell;
There's fever in the cesspool,
And sewage in the well.

It is estimated by Dr. Frankland that 12,000,000 of the inhabitants of this country derive their water supply from shallow wells. The analysis of the water of many of these wells shows how dangerous it is to the health of the people, and there can be no doubt of the fact that enteric diseases are largely propagated by the foul condition of this water.

What, then, is the remedy, and what are the difficulties of applying it?

In considering the defects of the existing law, the first point which is brought to our notice is that, although the Public Health Act provides the means of closing wells when the water is bad, there is no provision for enforcing a supply, at the cost of the owner or occupier, when a well has been closed, or when there is no supply at all. Again, you cannot enforce a pure water supply for the inhabitants of any place, where there are no public waterworks, and where the inhabitants get their water supply from any polluted source. I shall, perhaps, be told that there is power to enforce a water supply under section 62 of the Act 1875, but the construction put upon it by the authorities, though not very apparent on the face of it, is that it cannot be put in force unless there are waterworks in the district. This appears in the evidence given by Mr. Hugh Owen before the Select Committee on the Public Health Act Amendment Bill. He was asked, "Is not the 62nd section considered to apply only to cases where water mains are laid down, and what is required is to connect the houses with the main so as to secure a supply to the house?" and his answer was, "That is the view which has been taken of the effect of the section."

Let us consider what this means. It means that where there are no waterworks the inhabitants may, and I am afraid, from the apathy with which they regard this subject, do, make use of water which poisons themselves and distributes disease and death around. There is a case, mentioned in the sixth report of the Rivers Pollution Commission, of a pump at some cottages called Allen's-cottages, near Wokingham, in Berkshire, where there was nearly 13 times more organic carbon than the Commissioners laid down as the limit of wholesome water, and 100,000 lbs. of this water showed evidence of being derived from a source which was some time or other polluted with an amount of animal sewage equal to that contained in 184,000 lbs. of average London sewage. This water, the Commissioners say, was at least double the strength of London sewage; and a correspondent wrote to me, "you are quite right in saying that the water

of this pump is derived from a source 84 per cent. worse than London sewage. In other words, if London sewage, soaked through a few feet of gravel, supplied the well entirely with water, that water would be 84 per cent. better than the water of the pump was at the time it was analysed. If this is not cannibalism, it is an approach to it."

Such is an illustration of the state of things which the Bill that has now passed its third reading in the House of Commons is intended to remedy.

In considering how to achieve the object in view, the first point evidently was to establish some authority over the water supply of every district, and in all cases wherever a bad supply was found to exist, or where there was none at all, to compel a new one.

The Bill, however, proposes that the sanitary authority shall take action only on the report of the inspector of nuisances or medical officer of health. The object of this provision is that thereby the responsibility is thrown on those officials who are appointed to watch this important matter; and in another part of the Bill power is given to make such inspection as is necessary to carry out the object.

Where a sanitary authority are of opinion that a water supply ought to be provided, they may give the requisite notices calling upon the owner or occupier to provide a supply for the house, provided (and this is a most important provision) that the cost of providing the supply is not more than a capital sum, the interest of which at 5 per cent. would not exceed two-pence per week. The capital sum would be £8 13s. 4d. But where a water supply is difficult to obtain, and where such a sum would be too small, the is power given to the local authority to charge more, provided that the Local Government Board consider it reasonable to do so.

It may be said that the sum above mentioned, £8 13s. 4d., is very small for providing a water supply for a house, but, it must be remembered that if two houses are to be supplied, the amount will be double that sum, and if three houses, then three times that sum; and provision is made in the Bill that a common supply can be made for two or more houses, which I hope will take place in many cases. The evidence shows that the limit of cost in most cases would be sufficient. Mr. Rawlinson, in his evidence, says:—

"Rural inhabitants and landlords in rural districts sink wells so carelessly, and guard them so carelessly, that they simply give impure water from gross neglect; and a very small outlay, and a very small amount of care, would cause the polluted well to give comparatively pure water, and a small amount of continuous care would preserve it pure."

There are two conditions which I ought to mention with regard to the supply of water, first, that it shall be wholesome, secondly, that it shall be at a reasonable distance. These two points are not defined. I wish it were possible to define them, but they are left to the discretion of the magistrate, in whom I think we may safely place confidence.

The means by which water is to be supplied is not set forth in the Bill, but is left to be settled by the circumstances of each particular case. In some cases, the most convenient plan would be to collect water from the roof and store it; in others, to dig a new well; in others, to render the existing well good by puddling; in others, to bring spring water to a village or hamlet by means of a pipe. In others, again, recourse may be had to some form of pumping machinery, or by means of a drain to cut off the polluting matter, and thus render the well pure.

I now come to the appeal clauses of the Bill. It is possible that there may be some cases of hardship, and, therefore, it is necessary to give an appeal to some superior authority. An appeal, therefore, against a notice of the sanitary authority calling upon the owner or occupier to provide a water supply, has been allowed on five grounds.

1st. That the supply is not wanted.

2nd. That the time to comply with the notice is insufficient.

3rd. That it is impracticable to provide a supply at a reasonable cost, and an appeal on any of these grounds is to be decided by the magistrates.

The fourth ground of appeal is, that the authorities ought themselves to provide the supply; and the fifth ground of appeal is, that the district ought to pay the cost of providing a supply, or render the existing supply wholesome; and the appeal on these two last grounds is to the Local Government Board, because they alone have the staff and knowledge requisite to decide whether the authority should provide waterworks.

I now come to a very important provision, which affects new houses only, and which says that they shall not be occupied until there is a proper water supply. It appears to me that this goes to the root of the question. It is time that every authority should be armed with this power. If there is not a proper water supply to a house, it ought not to be inhabited. We must not, however, think that something very unreasonable is required. I believe, as a matter of fact, that before any public-spirited landlord builds a house in the country, one of the first things he considers is a good water supply.

The next point I have already referred to, namely, the power of inspection. It appears to me that local authorities ought to have just the same power for making inspections, for ascertaining the state of the water supply in their district, as they have for ascertaining the existence of nuisances. Both are matters which deeply affect the health of the people.

Such are the main provisions of the Bill, but there are others which I may call amendments of the law. For instance, it has been held that, where the Local Government Board had to settle what was meant by a reasonable cost, under section 62 of the Public Health Act, it was necessary to fix such cost with respect to each particular house in their district. This, of course, is a great trouble and of no corresponding advantage. Therefore, I have inserted a clause, which amends this point and gives the Local Government Board power to fix a general scale of charges for the district, when applied to by the local authority.

The next point is with regard to stand points. Where a water company supply by stand-pipes to a street or court of houses they may charge water-rents and rates upon the persons who use the water, but where a local sanitary authority supply water by stand-pipes, they cannot charge water-

rates and rents. The object of my amendment is to place the local authorities in the same position as water companies.

The next point, that of the incidence of water charges, is one of considerable importance. It is dealt with by a clause which was placed in the Bill by the Government after it left the Select Committee, over which I had the honour to preside. I am glad to bear my testimony to the readiness with which the Government have taken up one of the points which were mentioned in the report of the Committee. The report said :—

"The committee have had pointed out very forcibly to them that the prevailing practice with regard to defraying the costs of a water supply does not appear to meet the equity of the case. At present a sanitary authority may recover the cost of the water supply in either of the following ways:—

"1. They may charge the whole cost upon the rates, in which case it is paid out of the rate for special expenses; or,

"2. They may defray the cost by water-rates and water-rents upon the consumers of the water. These charges may be insufficient, sufficient, or more than sufficient, to meet the costs of waterworks. If they are insufficient, the rates have to make up the deficiency; if they are more than sufficient, the rates will be lightened by the surplus revenue derived from the waterworks.

"It appears to the committee that grave evils result from this state of things. It frequently happens, notably in rural districts, that the whole charge is borne by the parish under the rate for special expenses, while the supply of water is limited to the village or a porticular part of the parish. Those, therefore, who live outside the village or the part of the parish benefited by the supply, have to pay for the water from which they derive no advantage; this fact causes great opposition to schemes for water supply, and in many cases renders it impossible to carry them out. Special districts for drainage and water supply have been in ome cases formed, but objections are often raised to the formation of new areas, and in some cases special difficulties arise. For instance, when in a village some of the houses have water and some have not, and when these two classes of houses are intermingled.

"On the other hand, there are cases where the sanitary authority charge water-rates and water-rents, but the revenue from them is insufficient to defray the cost; here it is obvious that the cost of the water to the consumer is lightened at the cost of the rates. To illustrate this, suppose a case of a manufacture being established in which large quantities of water were used; it would be the interest of the manufacturer to have the water cheap, and the deficit of the water account thrown on the rates. In this case, again, those who do not benefit by the supply pay for those who do. Where, however, the price charged for the water is more than the cost of the supply, another grievance arises, viz., that the rates are lightened at the cost of the consumer of water. If a large ratepayer were not a large consumer, it would be his interest to have the total amount to be raised by rates lightened by the surplus profit derived from the waterworks.

"The committee, after full consideration of these cases, think that the sound principle to lay down is that water supplied by a sanitary authority should be paid for by the consumer; but, as it appears that this principle, if carried out to its full length, might, in some cases, cause the charge for water to be very high, it seems desirable that a maximum of charge on the consumer of water should be established. On the other hand, it has been shown to the committee that it is desirable to establish a minimum. It is obvious that a fair charge, made directly on the houses benefited, will tend to disarm the opposition which now arises on the ground that the cost of the waterworks will be thrown on the rates."

Now the gist of this is, shortly, that a number of persons are called upon to pay for the cost of waterworks, from which, when they are established, they will derive no direct benefit. Take the case of a parish, in which there is a village occupying a corner, with a number of farms around. If the village is supplied with water, and water-rates are not levied, the cost has to be defrayed by a rate for special expenses, to which those outside the village have to contribute, although they derive no benefit from the water supply.

The Government, however, have not adopted the recommendation of the committee on this point in its entirety in the clause they have inserted in the Bill, for they have only gone the length of saying that, on the application of a given number of ratepayers, the local authority is bound to raise (part at any rate of the cost of the water supply) by water-rates and rents. I hope that this step will be followed by others.

Besides some formal clauses which I need not notice, there is one which empowers the Local Government Board to confer the powers of this Bill or any of them on urban authorities. Unless there was a power of this sort, there might be a temptation to authorities to get made urban, and thus escape the duties thrown upon them. On the other hand, it would not be right to give urban authorities the power to work this Bill in all cases. For instance, it would be absurd to give an urban authority power to compel an owner to provide a wholesome water supply in a closely-built town, for he could neither get it from the heavens above, as rain water for it would be too smoky, or from the earth beneath, for it would be polluted with sewage. It is, therefore, necessary to give a discretionary power to the Local Government Board to apply the Bill to urban districts only where the powers of it would be useful.

I now turn to the report of the committee, which deals with some matters not in the Bill, the first and most important of which is the recommendation with regard to the taking of water otherwise than by agreement. All visible water in this country has some claim of ownership upon it, and any proposal to take it in order to supply a place with water raises a host of objectors below the proposed in-take if the water is taken from a stream. At present the only mode of obtaining compulsory powers for such purpose is by a private Act of Parliament. It was thought, until last year, that by the Provisional Order system water could be taken compulsorily; but that view has been upset by a decision of the House of Lords. The consequence is recourse must now be had to a private Act for taking water by compulsion, and as the expense of obtaining such an Act is very heavy, many small towns and villages are prevented from trying to get one. It is evident on the other hand that some machinery is necessary to prevent water being taken without adequate compensation to those who may be deprived of it, and therefore it is necessary to devise some system, as inexpensive as possible, by which the owners of water may be protected, and receive compensation if injured. Such an arrangement we find in the

Provisional Order plan, and the committee therefore recommend "that the Local Government Board should have power to issue Provisional Orders, which, when confirmed by Parliament, would confer upon the local authorities the power to purchase water compulsorily, such Provisional Orders to put in force the Water Clauses Act, 1847."

If this recommendation is adopted by the Government, as I hope and believe it will be, it will go a long way towards allowing authorities to obtain water at a less cost than at present. I do not say that it would put an end to all expense in such a case as the Manchester water scheme, for that would have been brought before a committee in any case, but in small plans for water supply it would save great expense, and judging from the analogy of those cases, where a provisional order can now be got for other sanitary matters at a very small cost, I am inclined to hope for good results from the proposed alteration of the law.

The second point in the report with regard to the incidence of water charges I have already referred to.

The third point in the report demands a few words of explanation. Water companies or Corporations often include within their limits of supply outlying districts, to which they intend to extend their mains at some future time, if it will pay them to do so; and they may be compelled to do so at once, if the inhabitants of any place guarantee 10 per cent. of the cost of the mains for three years. Such is the present law. Now, we all know that there must be great difficulty in getting the inhabitants to guarantee as required. A. would say that he will not help because he has a good well and, therefore, does not want the water of the water company. B. says he will not help because C., who is richer than he is, will not give anything. It is, therefore, proposed that the sanitary authority should have power to make the guarantee and charge it upon the rates, and also if they choose, to make the guarantee for a longer period than three years, and until the receipts from the water rates exceed the amount of the guarantee, but in this latter case, the guarantee is only to be 7 per cent. on the cost of the mains instead of 10. This would be an improvement in the law, as it would facilitate the extension of waterworks companies' mains to places in their districts not now supplied. Suppose a case where the cost of the mains would be £1,000. Under the present system, £100 a year has to be guaranteed for three years; but if the committee's recommendation is carried out £70 only will have to be guaranteed for no fixed period, but until the water-rates raised by the company exceed the £70.

In addition, the report points out that it is not reasonable to allow a water company or corporation to have assigned to it and not attempt to supply the outlying parts of its district, when the local authority of those parts is prepared to supply them with water, and that they should not be allowed to play the part of the dog-in-the-manager. For this purpose it is necessary to repeal section 52 of the Public Health Act, and insert an amended section in its place. With regard to this, the report says:—

"Where a district, within the limits of supply of a water company, is unsupplied, the local authority may require them to determine whether they will allow the local authority to supply, or whether they will supply the district with water themselves, or supply water in bulk, so that the authority may distribute the water. If the company inform the authority of their willingness to supply, they are to name a period before the expiration of which they will supply the district, and then they retain their right to supply to the exclusion of the local authority. If the company determine to supply the local authority in bulk, they shall state the price, the quantity, and condition of the supply. Provision is made for referring to arbitration any dispute which may arise as to the reasonableness of the time within which the supply is to be provided, if the water company provide the supply, and also as to the price, quantity, and conditions, if the water company agree to supply the authority in bulk. If after an arbitration the company decline to supply, then the local authority may supply, as if the district were not within the limits of supply of a water company. Further provision is made that, if the local authorty is supplied in bulk they may distribute the water, and also if the water company fail to do what they have undertaken, then the local authority may supply the district as if it were not within the limits of supply of a water company. The same regulations which apply to a water company should apply to any Corporation supplying water."

While I believe that this recommendation of the committee will not be considered unjust by water companies, I confidently expect that it will improve the water supply of many places.

I now come to my last point, which is the supply of water outside the limits of supply by a water company or Corporation to any village and hamlet, which is in want of a supply, and which may be situated in the district from which the supply is taken, or through which the mains pass. Is it reasonable that any large Corporation should have all to go to a district for water, and disregard altogether the wants of the district, and of the towns and village on the line of its mains? Granted that the necessities of large towns must overrido all other considerations; but where the supply is large it does appear reasonable that the towns and villages *en route* shall have the right to purchase some of the water for domestic purposes, provided that that is the best means of supplying their wants. It was suggested that rural authorities should be allowed to oppose a Bill where a large town proposed to take their water without supplying their district; but it is obvious that it would be a very unfair struggle between a small sanitary authority in Lancashire and the great town of Manchester, besides increasing the cost which is already too heavy. On this subject the committee "recommend that where a water company or sanitary authority go to a rural district for water, or where their mains pass through a rural district which is in want of water, they shall be compelled to supply the rural sanitary authority of that district with water in bulk at a cost which, failing agreement, should be settled by arbitration. The rural sanitary authority in that case should generally undertake the distribution of the water."

In conclusion, let me refer the attention of sanitary reformers to an able paper by Mr. Paget, which is to be found in the appendix of the report from which I have been quoting. This paper I believe the Government have had printed for circulation.

J. W. WILLIS BUND.

1. A large and comprehensive scheme of a national character, with regard to the water supply of the country, is practicable if a proper body is appointed to watch over it, and money provided to carry it out.

2. The country is by nature divided into a number of watersheds, and it was obviously intended that the supply of water, given by nature to each of those watersheds, should suffice for it.

3. Any really national scheme must, therefore, be based upon the principle that each watershed has, *primâ facie*, a sufficient supply of water for its wants.

4. If it is not so, the deficiency must arise from two causes, (*a*) the natural character of the district has been artificially altered, (*b*) the natural sources of supply are not available.

5. As to (*a*), this may arise from the increase of the inhabitants, or the introduction of manufactures, and on its being shown that the supply was insufficient from these causes, then the district might be allowed to obtain a supply from another district where there was a greater supply than the existing and probable wants of that district required.

6. As to (*b*), this must arise from some act of the inhabitants of the district, every means should therefore be taken to render such supply available, and, until it was clearly proved that all such means had been used and exhausted, no district should be allowed to resort to another for its water supply.

7. An account should be taken of the water supply of each district, shewing what is, and what is not, available, and if the supply of any is deficient, steps should be at once taken to utilise the existing source at present unavailable.

8. When that was done, if the supply was still inadequate, application might be made to some central authority asking leave to take water from another district.

9. Before the leave was granted, the applicants should prove to the satisfaction of the central authority (1) that they had utilised all their available sources of water, (2) that the supply of water to the district from which they proposed to take it was more than ample for any reasonable increase of population for a long period of years, (3) that all the districts through which the works abstracting the water passed should have on payment a right to be supplied, either at the present or at a future date.

10. No scheme to take water from another district should be submitted to Parliament that did not comply with the requirements of the last section.

GILBERT W. CHILD, M.D.

In reply to your letter, I would beg to observe that in any scheme whatsoever for the purposes of supplying the population of the country with water—if it is ever to get beyond the region of mere theory—the first principle must be that the supply shall be provided *at the lowest possible money cost* consistent with securing sufficient quantity and adequate purity. This principle at once excludes the idea, which the phrase "a large and comprehensive scheme" appears to some persons to suggest—of the selection of some one vast source of supply and its distribution by means of a gigantic system of mechanical arrangements over the whole country. It is simply inconceivable that villages situated, *e.g.*, on the lias or oolite formations, abounding in streams and springs of wholesome water; others on the dead flat of the Oxford clay, whence no water can be extracted fit for use, and where only an occasional stream rising in some more favoured district flows slowly across the surface, and others again high upon the chalk of the Chiltern Hills, where you may go for miles together without seeing a stream, and may bore 400 feet before you come to water—can all be *economically* supplied by the same means or from the same source.

I conclude, therefore, that the phrase in question is intended to apply, not so much to the mechanical means by which a water supply is to be obtained, as to the legislative and administrative machinery whereby we may insure that the population—more particularly that portion of it which inhabits the small towns and rural districts—shall all be supplied with wholesome and drinkable water, by whatsoever means may be shown to be most practicable in each separate district.

On this part of the subject I would point out:—

1. That it appears clearly to have been the intention of the Public Health Acts of 1872 and 1875 to provide for the above, as well as for several other purposes. This may be plainly seen by comparing Part ix. of the latter Act secs. 293—9, with the earlier provisions, secs. 51 *et seq.*; but that this intention has been frustrated in practice is only too notorious.

2. That it appears to be almost a certainty that permissive legislation will never effect a purpose such as that now under discussion, because a local governing body (such as a Board of Guardians) consists mainly of considerable ratepayers, whereas the persons who suffer from want of proper water-supply are chiefly the poor, who either pay inconsiderable rates, or none at all, and who are very inadequately represented in such a body.

3. A purely local organisation will not answer the purpose, inasmuch as the first considerations to be taken into account for the purpose of economical water supply will be the boundaries of parishes or townships, but not of watersheds, and still more of geological formations. An organisation in some respects resembling that of the Geological Survey, or the Ordnance Survey, must, in my opinion, be established, and must lay down the conditions under which the local authorities are afterwards to work.

4. In this, as in other matters having reference to local management, the first principle to guide future legislation, should be to avoid creating new jurisdictions for special purposes, without previously abolishing some, or if possible all, of those which now exist. The bane of all local government in England at the present time is the chaos of different and often conflicting authorities existing, each for a special purpose.

I have thus indicated, very shortly, what I believe to be the elementary principles upon which any great general improvement in the water supply of this country can be inaugurated. They amount to two, viz.:—

(1.) A moderate re-organisation of the machinery of local government; and

(2.) In the carrying out of the actual work required, due regard, before all other considerations, to the physical conformation, and the geological characters of each district which has to be supplied. These matters I shall be glad to explain more fully by word of mouth in the approaching Conference, should the Council think fit to permit me to do so.

REV. J. C. CLUTTERBUCK.

The question suggested in the letter of H.R.H. the Prince of Wales, and the solution of which is the object of this discussion, is:—"How far the natural water resources of the kingdom might, by some large and comprehensive scheme of a national character, adapted to the varying specialities and wants of districts, be turned to account for the benefit, not merely of a few large centres of population, but for the general body of the nation at large." This first involves the necessity of an extended and accurate knowledge of the source of all water supply, namely, the amount of rainfall throughout England, and the quantities of water which in various localities are available for supply, either by artificial or natural storage on the surface, or by absorption, in the various strata of which the country is composed; tested in the case of absorption by the volumes of streams and rivers which are the natural gauge of the quantities available for use, together with the possibility of extended and detailed distribution; this latter point requires special attention, as suggested by the Prince's letter. There are many available sources of information for the former; the latter presents the great difficulty to be solved. The total or partial isolation of the water sheds of the greater rivers, whether their waters are derived from one or various geological strata, seems to confine the supply to that locality. The Thames, as an example, derives its waters from various geological strata; the upper Thames from the oolitic, the lower from the cretaceous series; the upper for the most part making its bed in the clays, and the lower chiefly in the chalk formation, whence the greater part of its perennial waters are supplied. The intermediate spaces between the tributaries, especially in the chalk district and the river banks, rise to high elevations, to which the water must be raised by mechanical and artificial means, involving considerable difficulties and great expense, and consequently forbidding the adoption of any general system of detailed distribution. The same will apply, more or less, to all watersheds, and their rivers, and points rather to separate systems than any general system. These remarks apply rather to thinly than to thickly populated districts. The extension of population for manufacturing purposes, where the wants of the population has outrun the natural water supply, enhances the difficulties. Large centres of population need large and independent sources, and scarcely come within the limits of this inquiry. How the population can, under any circumstances, be supplied by any large and comprehensive scheme, it were hard to tell; at any rate, the mere fact of the existence of these difficulties seem to point to the necessity of a more extended and practical knowledge of the whole subject of the water economy of the country; the ordinary officers of the health Acts have little, if any, scientific knowledge of the question. Most ruinous failures, especially in boring for water without sufficient geological or hydrogeological knowledge even of the most elementary character, show that the present condition of the science—for science it really is—will not warrant any attempt at a large and comprehensive scheme, as suggested by the letter of the Prince of Wales. The extent of water supply, which, be it remembered, has its limits, and varies with times and seasons, must be more accurately ascertained. The rainfall even yet requires further investigation and practical knowledge by Mr. Symons and some others. There is a great and growing disposition, especially in and about the neighbourhood of London, to tamper with subterranean water, involving the danger of decreasing the volume of that which under natural circumstances flows in a more or less perennial form above ground, and ultimately diminishing the subterranean supply. Moreover, the present laws by which the interests of subterranean water are ruled can not be deemed satisfactory, or likely to lead to economy, which year by year is of greater importance. It is manifestly difficult to suggest any scheme by which increased and trustworthy knowledge of the great water question can be secured: that there is much to learn is manifest. The neighbourhood of London and its chalk basin has of late found a most industrious investigator in Mr. Joseph Lucas. Encouragement should at any rate be given to all such attempts at hydrogeological study, and it may be, as facts and information on this all important subject are obtained and recorded, the great and good object of the Prince of Wales's letter may find its fulfilment and reward.

SIR H. COLE, K.C.B.

Before, as one of the general public, I submit some few observations on the important question suggested by H.R.H. the Prince of Wales, "how far the great natural resources of the Kingdom might, by some large and comprehensive scheme of a national character, adapted to the varying specialities and wants of districts, be turned to account, for the benefit, not merely of a few large centres of population, but for the advantage of the general body of the nation at large," I ask for a general consent to a few propositions:—

1. That as the law already forbids poisoning the people by bad air, it should be admitted that every one has a right of obtaining pure water in sufficient quantity for his daily life as far as practicable.

2. That water fit for dietetic purposes can only be supplied after proper filtration; consequently, no river water, except at the very source of it, is pure enough, and well waters generally are rarely sufficiently pure for drinking purposes. The Duke of Somerset recently declared the use of rivers for drinking must be given up. As a general rule, the sparkling gaseous waters pumped up from the Metropolitan wells, and wells generally, are dangerous to health. Throughout Birmingham the well water is more or less poisonous, and unfit for drinking. The water in wells in cottage

gardens is generally tainted by drains, and the water of ponds ought not to be used even for cattle.

3. That pure water will increase the health and vigour of the people, and provide the best antidote to intemperance.

It appears to me that the plans now being discussed by London, Liverpool, and lately settled for Manchester, suggest the practicability of an extended action under national sanction.

That great districts should be bound to look after the supply of water, with due regard to the neighbouring small towns, and still smaller villages.

That the spirited example set by Manchester, of supplying a limited district, be accepted as wise and beneficial, and that the principle be applied to the whole kingdom, to be mapped and parcelled out into a sort of water heptarchy, with federative powers.

And that for reasons of economy and excellence of supply, the nation, through Parliament, should cause all great reservoirs to be provided for supplying the proper quantity of pure water, leaving towns and villages to construct all the local arteries.

At the present time the amount of the British rainfall is accurately known by the tables of Mr. G. J. Symons, and might be accepted for the purpose of the discussion of the question. Assuming that the annual supply of rain is about an average of 32 inches, it has been estimated that it is enough for a population twenty-five times greater than the present, including beasts and machines, but it is now nearly wasted,

The published Ordnance Survey of rivers and the catchment basins gives 215 basins for collecting water, and five, at least, may be selected to furnish the most abundant supplies. The greatest rainfall is in Northumberland and Cumberland, varying annually from 100 inches downwards. The Leven basin contains 202 square miles, and this source is about 260 miles from the metropolis. The next is the Conway basin of 222 square miles, with a rainfall from the Lledr of 98 inches, and another from Llugwy of 58 inches. The Conway basin is 200 miles from the metropolis. The third basin is the Dee (No. lxx. on map), with 813 square miles, with a rainfall at Bala of 49 inches, about 206 miles from the metropolis. The fourth and fifth basins are in Devonshire, the Dart (No. ccix. on map), with 200 square miles, and a rainfall of 79 inches; and the Tamar (No. clxxxvii.), with 385 square miles, and a rainfall of 59 to 39 inches. The water from these five great basins might be obtained direct from lakes or rivers, whilst the water stored in the earth in the Midland and Southern counties would be obtained by pumping.

The scientific application of these facts, and with the present amount of knowledge, would not appear to be difficult, so as to cause an adequate number of reservoirs, for the whole of the United Kingdom, to be provided. England and Wales might be divided into seven districts, each under a local Commission; let each district be confided to a competent well-known engineer, to prepare the plans necessary for it, and let these form a united Board for the discussion of general questions. I am informed, by one who has made the subject of water supply his study, that a year would be ample time to devise a general national scheme.

The general financial principles to govern the scheme should be the work of the Government. The capital required might be a hundred millions of pounds or more, but what is that, looking to the cost of railways, not quite so important as pure water?

FRANCIS R. CONDER, C.E.

Available Data.

The water supply of England and Wales is entirely derived from the rainfall.

According to rain-gauge measurement the average annual rainfall of England and Wales is equal to about 127½ milliards of metric tons of water. In 1872 it was 36 per cent. above that amount; in 1870 it was 18 per cent. below it.

The available water supply of England may be taken as equal to the minimum annual rainfall, less the quantity of water that escapes by evaporation and percolation. This difference forms the annual outflow of the rivers of the island.

No complete measurements of evaporation, percolation, or river outflow exist; and the available water supply of England is therefore an unknown quantity.

But, as an allowance of 50 metric tons of water per head per annum for every unit of a population of 25½ millions amounts to only 1 per cent. of the annual average rainfall, the water supply, in the dryest years, is ample to meet every demand, if it be properly distributed.

Natural Distribution.

The physical distribution of the water supply of England is into natural outfall districts; which are bounded by watershed ridges.

These districts may be conveniently grouped in ten provinces, mainly drained (according to Keith Johnstone) by thirty rivers, of an aggregate length of 2,357 miles. Many important streams, however, are not enumerated in this list.

Of these districts, four, comprising an area of approximately 24,400 square miles, have an outfall to the east; two, with an area of 13,000 square miles, drain to the south and west; and four, with an area of 21,000 square miles, drain towards the west. The rainfall over this last area averages 25 per cent. more than that of the eastern and southern outfalls; which are within 2 per cent. of one another.

No survey of the hydrography of England exists; and it is only possible to form a rough approximate estimate of the area, population, and rainfall of each of the ten natural outfall provinces. A sketch of this is given in the annexed table.

In the province in which the population is most dense, and the rainfall lightest (that of the Thames and Medway outfall) an allowance of 50 metric tons of water per unit of population per annum will require 2·6 per cent. of the annual rainfall of an average, and 3 per cent. of that of an unusually dry, year. Thus, under the most unfavourable circumstances, 33 times the quantity of water required for the domestic use of the inhabitants of the district falls within its water-shed within the year.

It may be inferred that any attempt to override the physical conditions of the country by pumping up portion of the natural water supply of one district, in order to convey it to a different province, is objectionable; not only on the score of cost, and of risk in the maintenance of great works, but further as involving gross neglect of the sources of supply proper to the consuming district.

Local Distribution.

The local distribution of the water derived from the rainfall of each natural watershed district will depend (the average quantity being ascertained) on two conditions. These are, the hypsometry, or surface undulations, of the district; and the pervious or impervious character of the soil. To determine these conditions, we require an orographical and a geological survey, accompanied with careful meteorological observations.

When the soil is pervious, there is often a natural storage of water beneath the surface, accompanied by a subterranean flow towards the sea. This flow may or may not follow the main lines of surface drainage, being determined by the lie of the strata. It is sometimes arrested or diverted by a fault, as appears to be the case with the water in the green-sand flowing towards London from the south. Careful hydrometric observations, by means of wells, borings, and pumping, are requisite in order to ascertain the main features of any great subterranean store of water.

Where the soil is impervious, it is either waterless, inasmuch as it throws off the rainfall by surface drainage and by torrents, or water-bearing, as impounding supplies of water in lakes, ponds, or marshes.

In the former case, much may often be done by collecting rain in cisterns or ponds. In the latter case, sources of supply for concentrated populations may be indicated. In any case a complete hydrographic survey is necessary, in order to understand the proper course to be taken, either for the collection or the distribution of water. In the absence of such a survey, any outlay is likely to entail waste.

There remains the case where (as in the French Province of Artois) an impervious stratum covers a water-bearing stratum, the supply of which is attainable by boring. There is reason to believe that this is the case with the water-bearing greensand in the valley of the Thames, to the south of the fault which is exposed at New-cross, and that an ample supply for the southern part of London may be attained by sinking artesian wells to the south of this fault. In this or any similar case, a hydrographic survey of the collecting basin, a geological survey of the entire district, and special borings, are necessary in order to determine the available character of such a supply.

Mode of Procuring Information.

Early in the year 1872, when the recent dangerous illness of H.R.H. the Prince of Wales had stirred the nation so deeply that any efficient sanitary legislation would have been welcomed by the public, the writer submitted to the Government (and subsequently in part published), observations as to the primary necessity of such a survey as would allow of the systematic preparation of a general scheme for the water supply and drainage of England. Unfortunately, the Local Government Board preferred to create numerous local authorities, unfurnished with any scientific information or direction. The dead-lock that has resulted in spite of an expenditure that already involves an enormous outlay, is notorious.

In 1872, great floods occurred in the valley of the Po. The Italian Government appointed, early in 1873, a Commission of seven members, all of whom were acquainted with hydraulics, to prepare a complete survey of the basin of the river. This was completed by the close of 1874; and an example is thus given of what is so urgently needed in the case of the valley of the Thames, as well as in those of our other rivers.

In 1875, at the Geographical International Congress at Paris, Commander Baccarini, Director-General of Hydraulic Works in Italy, read a report on the water systems of that Peninsula, from which it appeared that the lines indicated by the present writer (as above stated) had been almost exactly followed. Six tables were published by the department, presenting a compendious view of the hydrology of Italy. Of these the first is entitled "Hydrographic Compendium of the Italian Provinces, with Orographic, Geographic, and Climatological References." It indicates the area and population of each province, the position and altitudes of the towns, hills, and table lands, the areas of woods, lakes, and marshes, the lengths, profiles, and volumes of the rivers, the rainfall, and the temperature and barometric pressure.

The second table is a "Hydrometric Synopsis of One Hundred Rivers and Torrents of Continental and Insular Italy." It describes the lengths, profiles, maximum and minimum volumes, areas of basin, rainfall, and hydrometric observations of these streams.

The third, fourth, and fifth tables contain accounts of the water courses regulated by the State, of those administered by public companies, and of the utilisation of water as motor power. 1,853 miles of navigable rivers and water courses, 1,651 miles of irrigation and drainage channels, and 3,575 miles of river bank, are under the charge of the State. 7,196 miles of water courses are in the hands of 835 companies, which protect, drain, or irrigate 4,227,000 acres of land. The water power economised, in 12 only out of 69 provinces, corresponds to a force of 43,000 horses.

The sixth table gives a "Compendium of the Results of the Water Administration."

If we consider, with the Vice-President of the Supreme Council of Public Works in Italy, that "fluviatile hydraulics cannot approach the stage of practical application until a complete and accurate survey is made of every water course, describing all its essential conditions," we may inquire how tables similar to those described, which are requisite in order to afford the information without which any hydraulic works in England must be tentative and inefficient, can be most readily obtained.

Hydrology of England.

For constructing a compendium of the hydrography in England, the Ordnance Map would serve as a basis. Not only the topographic, but also the orographic and geological features of the country are ascertainable from that survey, where it is com-

plete. For rainfall observations we are mainly indebted to Mr. Symonds and his assistants. It would be necessary to provide for the systematic completion and maintenance of this system of observations, and for observations of evaporation and percolation. The same, or a supplementary compendium, should also contain the details, which have almost entirely to be collected, of the subterranean hydrometry of the country.

For a hydrometric synopsis of our rivers and torrents, the information has almost entirely to be collected. The minutes of the Transactions of the Institution of Civil Engineers show how extremely imperfect are the data yet available with regard even to the navigable part of the Thames. The neglect of the Shannon, if we glance at Ireland, is a subject of grave national dissatisfaction. The need of the information which this table would supply is urgent.

The materials for tables descriptive of the navigable canals of England, the great outfall, drainage, and irrigation works, the works for the protection of the fens, and the diversions of streams for the water supply of towns, have all to be collected. The latest Parliamentary return as to our canals, dated 26th April, 1870, is vague and imperfect; and we are indebted to a French author, the late M. de Franqueville, for the estimate that the aggregate length of the canals of England is 4,135 miles; of which 1,716 miles have been bought or leased by railway companies for the purpose (with one very lucrative exception) of obstruction; while a considerable proportion is in a state of dangerous decay. The compilation of tables corresponding to the third and fourth tables of the Italian Director-General is matter of urgent need for the welfare of the country.

A table corresponding to the fifth of the Italian series would have a special value. The richest lands of many of our river valleys are at all times water-logged, besides being subject to destructive floods. This is partly owing to the pounding up of the water, in order to turn mills, and partly to the barbarous and wasteful mode of irrigation by permanent ditches and grips. No arrangement exists, as a rule, for completely flooding, and completely draining, the water meadows at pleasure. Where Nature herself effects such an alternation, as in the case of the "Severn hams," the crops are repeated and heavy. Three rich grass crops in the year may be obtained with certitude by a proper regulation of the water. Swamps, reeds, and rushes now occupy a large proportion of that which might be rendered the most fertile land of the country. A general rectification of the water courses of our valleys would ensure an enormous increase of productive wealth, provide ample compensation for the loss of motor power, and materially benefit the public health.

For the sixth table of the Italian Government, which is not directly applicable under our arrangements in England, a table of a different kind might be substituted with advantage. This would contain the chemical analyses of the different rivers, streams, springs, and other sources of water supply; and the indications of the various works (mining, manufacturing, and sanitary) which affect the purity of the water.

Under this head would be tabulated the various tentative measures now in progress for the removal or the disinfection of sewage, the cases where, in defiance of the public welfare, crude sewage is thrown into water, the methods employed for purification, the degree of purity of the effluent water, and the general chemical condition of the entire river system of the country. Notes might advantageously be added as to the presence, abundance, and quality of fish.

Outfall Provinces of England.

Main rivers.	Area. 1,000 sq. miles	Rainfall Inches.	Population. Millions.	Water supply. Milliards of tons	Water required. 10,000 of tons.	Courses. Miles.
1. Tyne, Wear, Tees	3	41·17	1·5	7,904	7,500	200
2. Ouse, Humber, Trent......	9·4	30·88	4	18,577	20,000	234
3. Witham, Welland, Nen, Great Ouse, Stour, Blackwater	6	29 11	2	11,178	10,000	534
4. Thames, Medway	6	24·56	5	9,431	25,000	270
5. Test, Avon, Stour	5·5	3[illegible] 16	1·5	16 190	7 500	166
6. Exe, Tawe	7·5	33·73	2	10 616	10,000	107
7. Parret, Avon, Severn, Wye	8	33·97	3	11,392	15,000	444
8. Usk, Towy..................	7·5	46·15	2	22,152	10,000	144
9. Dee, Mersey	3	38·74	3	7,438	15,000	161
10. Ribble, Lune, Eden........	2·5	41·17	1·5	6,587	7,500	95
Totals........	58 4		25 5	127,465	127,500	2,355

Direct Utilisation of Rain.

Possessed of information of the above nature as to the hydrology of England, the engineer would find but little difficulty in pointing out proper measures to adopt for the service of any particular district. There would then remain for discussion the question of the best method for the direct utilisation of the rain water collected on the roofs of houses.

A house covering the small area of six perches of land receives annually on its roof more than 150 metric tons of water, being enough for the annual domestic consumption of three individuals. On the 122 miles area of London, after deducting more than one-fifth of the surface for roads, streets, and squares, 150 millions of metric tons of water fall within the year; a quantity equal to the requirements of three millions of inhabitants.

Rain water, while better then any other for some purposes, is usually unpalatable. In large towns the atmosphere is washed by rain, and the water descending, laden with extraneous matter, into open vessels, becomes offensive.

How far this may be prevented by causing the rain water to pass at once into closed vessels through prepared charcoal, spongy iron, or some other filtering surface, is a question to which the attention of chemists may be advantageously directed. It is not unreasonable to suppose that a considerable relief from the pressure on the sources of artificial water supply in towns may result from a careful study of the best method of utilising direct rainfall.

Practical Conclusion.

The problem now before us is that of the collection and distribution, in a pure condition, of less than one per cent. of the rainfall of England.

This is not a problem of great inherent difficulty, if the proper course be taken for its solution. The first indispensable step is the collection of the

hydrological data. There is not a single river in our island as to which we are in a position accurately to strike the balance between the rainfall over its basin, and the escape of the amount by evaporation, by sub-aerial, and by subterranean discharge. Any works attempted in ignorance of the hydrography of the district in which they occur, tend to complicate the general problem. It is impossible to separate the question of water supply from that of drainage, for this reason. Every ton of water brought into a town or house has to be removed when its work is done. Thus water supply and drainage are as closely related as are concave and convex. Not only are the constructors of works carried on in partial or total ignorance of the general hydrography of a district likely to neglect natural resources, but they may inflict irreparable injury on other districts.

Thus we see, at the moment when the wants of the rural districts are so great as to have attracted the attention of H.R.H. the Prince of Wales, schemes of alarming magnitude proposed in entire ignorance of the main controlling facts. It has been proposed to decant into the valley of the Thames, the head waters of the Colne, the Wye, the Severn, the Dove, and the Eden. The natural sources of supply that exist on the right bank of the Thames are, in the mean time, left without investigation. The grave consequences of the wholesale contamination of the Thames by the Metropolitan Board of Works are begining to excite anxiety (as anticipated by the present writer in 1873). At Carnarvon, Hastings, Margate, Brighton, Glasgow, and other places, the construction of what are called sanitary works are creating intolerable nuisances, perilous to human life. The unregulated action of a host of incompetent local authorities is rapidly tending to render parts of the country uninhabitable, and to convert an engineering question, originally simple, into one of invincible difficulty. Such is the natural result of the commencement of numerous hydraulic works without the previous completion of an hydrographic survey.

In what manner existing information can be most readily collected, existing machinery made most available, and the great national need for information most promptly supplied, in accordance with our usual mode of conducting business, I am prepared to indicate if desired. The subject is one as to which we can ill afford to make any more mistakes.

J. BAILEY DENTON.

I have to acknowledge your circular letter, enclosing a letter of H.R.H. the Prince of Wales, in relation to a general supply of water to the country.

No one who has given attention to the subject can doubt that great advantage will result from the public discussion which H.R.H. has initiated, for, although, it is not possible to devise any one scheme of works, or mode of supply applicable to the whole country, it is equally certain that it will only be by a perfect comprehension of the facts bearing upon the subject that any general action can be taken.

To secure general action of any kind it is necessary that everyone should be convinced in the first instance that there exists at command a superabundance of water for all present and future requirements, even in the driest years, not by mere general statements, but by sufficient data to satisfy the most critical minds; and, in the next, that it only requires appropriate legislative facilities and a proper presiding control to develop the special capabilities of districts under their varying conditions, and to satisfy small villages and rural districts as well as towns and wealthy places.

To realise the first consideration, it is desirable that the following data should be before the meeting:—

1. The quantity of water falling upon the surface of England and Wales, in the shape of rain—which is the source of all water supply—taking the total area to be 37,324,883 acres, and the average annual rainfall to be 32 inches, is 27,019,632 millions of gallons per year, which is equal to a supply of 723,904 gallons per acre.

2. The present population of England and Wales (1878) may be taken to be 25 millions—almost exactly two persons to every three acres of surface—and if this number be multiplied by 25, which may be taken to be the number of gallons required per person for all purposes, public as well as private, the quantity of water at present wanted would amount to 625 millions of gallons per diem, or 228,125 millions per annum, and if we double this quantity for future requirements and add to it the quantity of water consumed by farm stock, horses, and other animals, and that which is lost by conversion into steam, the total quantity prospectively required for all purposes may be put at 500,000 millions of gallons per annum. This it will be seen is equal to 1-54th part of the *average* rainfall.

3. The *minimum* quantity of rain that has been known to fall on the surface of England and Wales in any year within the period during which there has been any systematic record of the rainfall may be taken to have been 22 inches, or about $35\frac{1}{2}$ times the necessary provision, but inasmuch as a quantity approaching three-fourths of the rainfall (in dry years) is lost by evaporation as soon as it reaches the surface, there practically remains in such years only $5\frac{1}{2}$ inches of water to maintain the river systems. This minimum depth of rain, however, represents about nine times the quantity of water required for all purposes, when the present population of the country shall have been doubled, say 50 years hence.

4. The *maximum* quantity of rain falling on the surface of the country may be taken to be as much above the average fall as the minimum is below it. At least 40 inches of rain falls in the wettest years, and then as much water runs to waste and causes injury in the shape of floods and freshets as equals the whole rainfall in the driest years.

To realise the second consideration, the following physical and social facts should be recognised:—

1. That rain falling on uncultivated surfaces, naturally impervious and for the most part so much elevated as to be beyond the pernicious influence of human habitations and trade emanations, is the best of all waters for domestic supply, and is capable of storage to a very great extent as such.

2. That all rivers and water courses originate in springs issuing from the water-bearing strata, and are maintained by the rain as it is absorbed at their

surfaces. These springs, as they issue from the surfaces, remain, with few exceptions, as pure at the present time and are as serviceable for potable use—if their position were known and recorded, and their volume collected and stored—as when the country existed in its aboriginal condition.

3. That the water-bearing strata which absorb, store, and eject, in the shape of springs, a considerable share of the rainfall, represent at their outcrop the larger proportion of the surface of England and Wales. The waters collected and stored in their subterranean depths are capable of affording to towns and villages singly, or in combination, throughout the breadth of their outcrops a very large and cheap supply, if the condition of those subterranean waters were accurately known and tangibly recorded.

4. That in wet years, when a large proportion of the rainfall is not absorbed but passes at once off the surface to collect in the valleys on its way to the sea, there exists a capability of storing such surplus water not for potable use, for which it is unfit, but for compensating rivers and streams for the abstraction of pure water at their sources.

5. That all our principal rivers, and the majority of the tributary water-courses which support them, as soon as they form a collected volume, become unfit for potable uses, owing to their position as the drains of valleys whereby they must receive all liquids flowing off the surfaces within their watersheds, let the condition of such liquids be what they may. Although rivers and streams, however, when once contaminated with putrescible matters, cease to be serviceable for human consumption, they may be retained for use in trade and agriculture, and for the production of fish, if certain standards of purity for liquids admissible into rivers were adopted and enforced, such as were suggested by the Rivers Pollution Commissioners.

6. That no jurisdiction of rivers can fully develope their capabilities that does not extend from their source to the sea, and that inasmuch as many springs which feed rivers rise at a great distance from their trunks, and flow by minor courses through private properties, it follows that no conservancy can be perfect which does not extend beyond the main rivers and minor streams to the extreme watershed that is tributary to them. All springs which maintain rivers, and rise in private estates, and are thus made private property, should be guarded by conservancy as vigilantly as the river courses themselves, on the ground that they contribute to the general water supply of the country, and should be available for human consumption at their source before pollution. Many of the streams fed by these springs, and by the water of under-drainage, being polluted by mixture with the off-flowing water from cultivated surfaces, may be restored to a safe condition by filtration through natural soil, and thereby rendered fit for human consumption, where waters from uncultivated surface, or from springs, or from subterranean water beds cannot be directly obtained.

7. That Parliamentary powers are frequently sought, and occasionally obtained, enabling large and wealthy communities to obtain supplies of water from distant river basins, irrespective of local and prospective demands, before the capabilities of the basins within which such wealthy and large towns exist have been exhausted, although the committees granting these powers are incompetent in themselves to appreciate the difficult questions involved in the water economy of a country, the population of which has doubled itself within the last 50 years, without any means of extending its supercfical area or of increasing the rain falling upon it

As it is the wish of H.R.H. the Prince of Wales to ascertain "how far the great resources of the kingdom might, by some large and comprehensive scheme of a national character adapted to the various specialities and wants of districts, be turned to account for the advantage of the general body of the nation at large," I desire to express my conviction that if by the term "large and comprehensive scheme of a national character," it is suggested that one scheme of works, or one mode of supply can be devised which shall be applicable to the whole country, I am not of opinion that such an object is practicable. The great difference that exists in the rainfall as a source of supply, the diversity of surface, the variety of soil upon which the rain falls, and the irregular denseness or sparseness of population in proportion to space, forbid the realisation of such an idea.

I am, nevertheless, perfectly convinced that if there existed (1) a proper conservancy of rivers extending over the whole area of their basins, (2) an exact knowledge of the hydro-geological conditions of each river basin, and (3) legal facilities for dealing with the water raising up within, and flowing through, and existing under private properties, there would not be a single village in the country but might be abundantly supplied with pure water.

To render river conservancies competent to exercise that control over river systems, which would preserve riparian and private rights, while securing to the public the enjoyment of the chief element of health—pure water—the first step to be taken should be the collection of all existing information bearing upon the surface and subterranean waters within each river basin, prepared on such a form as to be immediately available and capable of enlargement as fresh information may be obtained. At present there is no reliable record of such data within the reach of either local authorities or engineers, although a mass of information exists in a scattered and very costly form, in the Ordnance and Geological Survey Departments, which might afford data whereby neglected springs and subterranean waters might be turned to account. Were this information obtainable in an authoritative shape, the indisposition of the owners of landed estates to place at the service of sanitary authorities the sources of supply which they possess by territorial right would cease to operate as injuriously as it now does.

Numberless examples of what may be done in the way of water economy, by the use of wheels, turbines, rams, and pumps, and in the way of storage, for village supply, are to be found scattered over the whole face of the country. If these instances, instead of being disregarded, or only cursorily mentioned in Parliamentary Committees, were carefully examined and described in a popular, but practical form, the serious want of water experienced in villages and rural districts, which induced H.R.H. the Prince of Wales to

come to their rescue, would vanish in a great majority of cases, though, so long as permissive laws stand in the place of compulsory laws in a matter of such vital consequence to every one as pure water, and Boards of Guardians are the judges of the time and course of action, so long will the present state of things exist.

During the last Session "The Limited Owners Reservoirs and Water Supply Further Facilities Act, 1877," was passed, enabling landowners to construct works of water supply on their own estates, after having entered into a contract with any neighbouring sanitary authority, to supply the inhabitants of their district with water, to borrow money for the purpose, and, with the approval of the Inclosure Commissioners, to charge their estates with the amount borrowed. Two conditions are imposed: first, that the amount borrowed should be repaid by instalments extending over a limited period of years; and second, that the income to be derived from the sanitary authority for water should be sufficient to satisfy the Commissioners that the reversionary interests in the estates charged will be benefited by the transaction. If the powers of this Act were judiciously administered, they would work most advantageously to the country, So comprehensive are its provisions, that a landowner can not only construct reservoirs, or erect dams, for the storage of water, but he may utilise springs issuing from the surface, or he may sink wells into a water-bearing stratum, and having secured a sufficient quantity, conduct it by proper service mains, in connection with suitable appliances, to any inhabited district within reach.

In the present Session of Parliament, "a Bill to amend the Public Health Act, 1875, so far as relates to the supply of water," has passed through Committee. Its object is, primarily, to compel the owners of small dwellings in rural districts to provide water where it does not exist "within a reasonable distance;" and, secondly, to facilitate the acquisition of a district supply where it is shown that a general provision would be more economical than separate arrangements. To those who are intimately acquainted with the conditions and influences which govern rural districts, and know that the owners of cottages in villages are generally persons of small means, with very limited belief in sanitary benefits, while the members of Board of Guardians, who are to order the water to be supplied, are themselves, for the most part, the employers of the labourers who occupy those cottages to be supplied, and who will, therefore, have to pay for the water in one way if not in another, this Bill does not promise much. It is believed that the want of proper dwellings for rural labourers, and the absence of all profit from cottage-building are difficulties in themselves, which should be overcome before it is legally declared that the cost of providing water to cottages in a village should be borne by the owners of those cottages rather than by the village community as a body.

In the last number of the *Journal*, p. 688, in the list of contributing companies to the London Technical Institute, the name of the Sadlers' Company was inserted instead of the Salters' Company.

MISCELLANEOUS.

JAPANESE TEXTILE FABRICS.

Calling attention to a fine display of Japanese woven and embroidered stuffs—the spoils of a temple and palace in the centre of Dia-Nippon—exposed for sale in New York, the *Tribune* gives an account of this branch of ancient Japanese manufacture. For years past, says the writer, we have been familiar with Japanese silks, such as were offered for sale in dry goods stores, especially made for the European and American markets; but what has been excessively scarce and until now almost unknown are the woven stuffs, brocaded dresses, and embroideries that were worn by the princes and daimios of a period at which the most remarkable manufactures were made, like Sèvres porcelain, only for presentation pieces, or for the use of crowned heads.

For the artist and the collector the study of such stuffs affords an unusual interest, for it shows even to better advantage that subtle quality of ornamentation which makes Oriental art so interesting. The first impression received on seeing these superb textures is one of exquisite delight at the perfect harmony of design and colour; but, as the eye wanders over the stuff, new details appear in every spot. The colour of the groundwork changes, and so does that of the ornamental pattern, but on several yards of stuff the same juxtaposition of colour between the ground and the ornament will not be repeated, thus affording great interest to the observer. The robes of the princes were of large dimensions—which seems singular when we think how low in stature the Japanese race is—and out square, for their artistic sensibility is so acute that they could not have the heart to cut "bias" through a beautiful pattern. This detail is not without interest, for we can take the dresses apart and use the wide bands of stuffs for decorative purposes. The lining used for each dress is always in perfect harmony with the outside hues of the garment, which offer the most striking variety, even in one single piece. The dresses of musicians, jesters, priests, and lords, though cut in the same shape, are ornamented in a manner suggestive of occupations of the wearers. Some are so heavy with gold brocade that their weight is nearly sufficient to bear a man down; but in all cases that most exquisite harmony of colour, which is such a relief to us after all the dogmatic art we have suffered under so long, is carried out in the most delightful fashion. These people, who live in abodes that are more like tents than houses, and who, thanks to the glorious climate of their country, are always out of doors, seem to imbibe the influence of the magnificent colouring of nature by which they are always surrounded. Japanese art is true art in the fullest acceptation of the term; that is, a simple rendering of nature, without any effort of the brain. When imagination comes in play, then it introduces those terrible, though gracefully curved monsters which astonish us and set us thinking, for their magnificent grotesqueness does not interfere with the general composition of the design, but only enhances its beauty by strong contrast.

The metallic threads used in their brocades are always made of paper, gilt or silvered; for the Japanese are masters in paper manufacture. This has a two-fold utility; while it makes the stuff more rigid, it does away with the hard cracks which occur in pieces where gold thread of inferior quality is used, for real gold thread is too costly to be used, except in church ornamental work, and, even then, only for pieces used on the altar. In some of the finest embroidery, such as was made for the hangings of temples, the gold work on the dragons is heavy enough to introduce glass eyes and metal claws,

which help very much in making the monsters terrible. In embroidering on crape—such as is know in the trade as *crêpe de chine*—the Japanese are without rivals. They use a peculiar method of reserving certain parts by painting them over with a chemical, which prevents spots thus prepared from taking the dye. In this way, when the stuff comes out of the dye-vat, an important part of the ornamental design is already indicated by white masses and lines. Plaids produced by lines of different colours and thickness, intersecting at right angles, seem to have been used by them long before they became identified with Scotch fabrics.

INDIAN LAC MANUFACTURE.

Lac, in its raw condition, is, as is well known, found incrusted round the twigs of the trees in which the insect feeds. The twigs are generally for convenience of transport brought to market cut up in lengths of two or three inches, and it is probable that a great deal of material is wasted in this process. The objects of the manufacture are, first, to separate the resinous incrustation from the wood; second, to free the resin from the colouring matter; third, to convert the resin into what is known as shell-lac; and, fourth, to form from the colouring matter cakes of dye known as lac-dye. As generally practised, these processes are conducted in a primitive manner. Mr. O'Connor, from whose notice upon the Indian lac in all its branches the following particulars are taken, was enabled to see the extensive lac factory belonging to Mr. Elliott Angelo, of Cossipore. The manufacture is there conducted on an improved and civilised system by the aid of machinery worked by steam power. The lac is first separated from the twigs by the action of rollers, worked by steam. Of these rollers, there are three sets, each consisting of an upper and under roller with a sieve attached. Between these the twigs pass from a feeder, and the lac is, by the turn of the roller, separated from the wood and broken up, falling on to a sieve, while the twigs are thrown off aside in a heap. If the lac has not been sufficiently broken up by the first roller to pass through the sieve, some of the twigs not having been separated, it passes on to the second roller and goes through the same process, passing again if still not fine enough to the third, whence the lac is dropped, as the sieve is filled, into a series of small troughs arranged in an endless chain working with the machine, and is projected thence, as the chain moves, into a heap upon the floor. The twigs are thrown off on to a platform on the other side. These are afterwards again examined by women, and all the remaining lac separated by hand, and as far as it may be worth while used in manufacture. The refuse is bought by natives for the manufacture of various articles made of lac. The sticks are used for fuel in the furnace of the steam-engine.

The lac is now placed in a horizontal cylinder furnished internally with arms, arranged on a bar passing through the cylinder from end to end. These arms are worked by steam power, and their action, combined with water, with which the cylinder is filled, breaks up the lac into very small pieces, and separates the colouring matter which forms lac-dye. Lime is frequently employed to assist in the precipitation of the dye when the water is not naturally impregnated with lime. In the liquid thus obtained the lac is left to soak for twenty-four hours in a large vat, the liquid being then drawn off by the removal of plugs into a vat on a lower level, and there left to settle in the same way as indigo, the colouring matter being precipitated to the bottom. The clear water at top is drawn off, and the sediment, after having been passed through a strainer—much of the same nature as that used by papermakers for the straining of pulp—is finally allowed to settle and consolidate, when it is pressed in frames into cakes, which are afterwards dried in the sun. These cakes are the lac-dye of commerce.

The lac, now called "seed-lac," after maceration, is thoroughly melted in a close vessel heated by steam, and thence conducted into open shallow troughs, also heated by steam, where the melting continues. Some resin is here mixed with the lac, to act as a flux and to prevent the lac from burning and adhering to the vessel. The resin, which is probably useful for this purpose, flies off, at least in great part, during the process of ebullition.

Ranged round the troughs are a series of zinc columns, inclined outwards at an angle of 45°. These columns are hollow, and, being supplied by pipes with tepid water, are maintained at a certain temperature. They must never become too hot, or the fluid lac would not consolidate; nor must they become too cool, for then the lac would harden at once, and break up into small fragments, which would adhere to the surface of the column. A quantity of the melted lac is now taken up by a workman in the concavity of a piece of plaintain bark—this being the material best adapted to the purpose—and flung on to one of the columns. Here, the liquid mass is spread evenly and thinly over the surface by a man, who makes use, for the purpose, of a leaf of the pine-apple plant, or some other tough, fibrous material. The leaf being held in both hands, its edge is drawn over the material until the mass is properly spread over the surface of the column to the required degree of fineness. It begins to consolidate at once, and becomes of a pliable, leathery texture. As soon as the lac is thoroughly consolidated, it is taken off by a workman, while still so hot that it would burn the fingers of any person not accustomed to the work, a considerable section of the upper portion of the sheet of lac being torn off, because it is thicker there than in the rest of the sheet, and thrown back into the trough to be melted again. The sheet is placed on a rod held in readiness by a woman, each extremity of the sheet hanging down, like a towel on a rack, and the whole is hung up to dry in a large drying shed, the rods supporting the lac being ranged on supports running across the sheds from side to side, just like a tobacco drying-house. The next day it is fit for dispatch, and it is then packed in boxes and sent away. The various qualities of shell-lac are known by different names and marks, and there is a considerable range in prices, from "Fine Orange DC" to "Livery," "Garnet," "Native Leaf," and "Button." The last quality is so named from the lac not being made in sheets but dropped from a height and solidifying into masses.

In India lac is used chiefly for the manufacture of bracelets, rings, beads, and other trinkets, worn as ornaments by women of the poorer classes. The lac is bought in the bazaar, and, after having been melted, it is mixed with vermilion, arsenic, and lamp-black for colouring purposes. It is also used as a varnish, in many cases the dye being left in the lac to produce a coloured varnish; by the turners of wooden toys, which are coated neatly with coloured compositions, in which lac predominates; in lacquered ware; and by goldsmiths for the colouring of the metal. In Burmah it is also employed to fix the blades of knives and similar instruments in their handles. In Bombay Presidency and elsewhere lac is also used in manufacturing grindstones, for which purpose three parts of river sand and one part of clean seed-lac are mixed over a fire, the mass being formed into the shape of a grindstone, having a square hole in the centre. This is then cemented on to the axis with melted lac, and the stone, having been moderately heated, it is caused to revolve rapidly, when it can easily be turned down to shape. The sand should be finer and the proportion of lac greater when the stone is only required for polishing. Japanese lacquered ware is made of an entirely different material, being a varnish obtained from the gum exuding from certain trees.

In Europe, lac is largely used in the preparation of

varnishes and by hatters. The body of all the silk hats in common use is rendered stiff and waterproof by the liberal application of a composition of shell-lac, sandarach, mastic, and other resins, dissolved in alcohol or naphtha. The brim is always imbued more thickly than the body with this varnish. Lac is also extensively used in the manufacture of sealing-wax, which is formed of an amalgam of shell-lac, Venice turpentine, colophony, and colouring matter, the quantity of lac used being equal to that of all the other articles put together. Lac also enters largely into the composition of lithographic ink, and in the preparation of lake (the name is derived from "lac"). Lake, however, is also made with madder and cochineal. Lacquer is based on a solution of shell-lac in alcohol, coloured with gamboge, saffron, &c. It is used to give a golden colour to brass and other metals, and to preserve their lustre. In India, lac-dye is mostly used to dye silk, and to some extent it is also employed in the dyeing of leather. It is not much used as a dye for cotton, on account of the expense.

GENERAL NOTES.

Railway Carriage Windows.—An improvement in railway carriage and other windows, patented by Mr. H. C. Gover, was shown at the meeting of the Society on the 29th May. The window opens from either side, in addition to the usual up and down movement, acting when so opened as a shield against the wind and dust. There is on each side of the window frame outside, a movable head, which guides the sash in its usual upward and downward motion, and which, in connection with a flange on the sash and a groove in the frame, form a hinge, on which the sash turns. The movable head when pressed back—which is done by finger pressure on a button inside the carriage—releases the sash on the side pressed, and allows it to be opened out on the hinge of the opposite side, a connection between the two sides preventing both being opened at once. The movable beads, acting with a spring upon the sash, prevent shaking; and a falling ledge, which holds up the sash, does away with the present necessity for throwing the sash over a ledge to keep it up.

MEETINGS FOR THE ENSUING WEEK.

Mon.....Working Men's Club and Institute Union (at the House of the Society of Arts), 7 p.m. Annual Conference of Delegates.
Royal United Service Institution, Whitehall-yard, S.W., 8½ p.m. 1. Captain A. Stewart Harrison, "The 'Burgoyne,' or combined Pick and Shovel." 2. Exhibition of Steel Mantlets and Shields for Troops.
Asiatic, 22, Albemarle-street, W., 3 p.m.
Social Science Association, 1, Adam-street, Adelphi, W.C., 8 p.m. Mr. Joseph Brown, "The question of the Masters' Liability for Accidents to their own Servants through the faults of Fellow-servants. Can it be fairly settled by making Insurance out of Wages compulsory?"

Tues. .. Association of Gas Managers (at the House of the Society of Arts), 11 a.m. Annual Conference.
Royal Institution, Albemarle-street, W., 3 p.m. Rev. W. Dallinger, "Researches in Minute and Low Forms of Life." (Lecture III.)
Statistical, Somerset-house-terrace, Strand, W.C., 7¾ p.m. Mr. James Heywood, "The Owens College, Manchester, and a Northern University;" to be followed by the adjourned Discussion on Mr. Newmarch's Paper.
Zoological, 11, Hanover-square, W., 8½ p.m. 1. Mr. Edward R. Alston, "The Squirrels of the Neotropical Region." 2. Mr. P. L. Sclater, "A Third Collection of Birds made by the Rev. G. Brown, C.M.Z.S., in Duke of York Island and in its vicinity." 3. Mr. A. H. Garrod, "Notes on the Male Hippopotamus which recently died in the Society's Gardens."
Royal Horticultural, South Kensington, S.W., 11 a.m.

Wed. ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8.30 p.m. Annual Conversazione at the South Kensington Museum.
Association of Gas Managers (at the House of the Society of Arts), 11 a.m. Annual Conference.
Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. A. J. H. Crespi, "The Climate of Lundy Island." 2. Rev. Samuel Barber, "On the Auroral or Magnetic Cirrus." 3. Dr. Robert James Mann, "Contributions to the Meteorology of Natal." 4. Mr. William Ellis, "Note on the Mean Relative Humidity at the Royal Observatory, Greenwich." 5. The Hon. Ralph Abercromby, "A Method of sometimes Determining the Amount of the Diurnal Variation of the Barometer on any particular day." 6. Mr. G. M. Whipple, "The Relative Duration of Sunshine at the Royal Observatory, Greenwich, and at the Kew Observatory, during the year 1877."
Geological, Burlington-house, W., 8 p.m. 1. Prof. J. Prestwich, "The Section of Messrs. Meux and Co.'s Artesian Well in the Tottenham-court-road, with notices of the Well at Crossness, and another at Shoreham, Kent; and on the probable range of the Lower Greensand and Palæozoic Rocks under London." 2. Mr. Charles Moor, "Notes on the Palæontology and some of the Physical Conditions of the Meux Well Deposits." 3. Mr. W. Keeping, "*Pelanechinus*, a new genus of Sea-urchin from the Coral Rag." 4. Mr. E. Tully Newton, "Remarks on *Saurocephalus*, and on the Species which have been referred to this genus." 5. Dr. A. Wichmann, "A Microscopical Study of some Huronian Clay-slates." Communicated by Mr. H. C. Sorby. 6. Mr. C. E. Austen, "On the Distribution of Boulders by other agencies than that of Icebergs." 7. Mr. T. Mellard Reade, "A Section through Glazebrook Moss, Lancashire." 8. Mr. C. B. Brown, "The Tertiary Deposit on the Solimoes and Javary Rivers in Brazil," with an Appendix by Mr. R. Etheridge. 9. Mr. J. Clifton Ward, "The Physical History of the English Lake-district, with notes on the possible sub-divison of the Skiddaw Slates." 10. Mr. J. E. Marr, "Some well-defined Life-zones in the lower part of the Silurian (Sedgw.) of the Lake-district." Communicated by Prof. T. M'K. Hughes. 11. Mr. F. Ruddy, "The upper part of the Bala Beds and Base of Silurian in North Wales." Communicated by Prof. T. M'K. Hughes.
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m. Mr. T. H. Baynes, "A Gold Signet Ring found by Dr. Schliemann, at Mycenæ."
Society for the Development of the Science of Education, United Westminster (Endowed) Schools, Alexandra-street, Victoria-street, S.W., 7.30 p.m. Rev. R. H. Quick, "Some Difficulties in School Teaching."

Thur. ...Antiquaries, Burlington-house, W., 8½ p.m.
Linnean Society, Burlington-house, W., 8 p.m. 1. Mr. C. B. Clarke, "Two kinds of Dimorphism among the Rubiaceæ." 2. Capt. W. E. Armit, "The presence of the Echidna (*Tachyglossus*) and Ornithorhynchus in Northern and North-Eastern Queensland." 3. Mr. N. E. Brown, "The Stapeliæ of Thunberg's Herbarium, with a description of new species." 4. Dr. J. Murie, "Observations on the White Whale (*Beluga leucas*) exhibited at the Westminster Aquarium."
Chemical, Burlington-house, W., 8 p.m. 1. Messrs. Y. Stenhouse and C. E. Groves, "Contributions to the History of Naphthalene. II. B. Naphthaquinone derivatives." 2. Mr. G. Harrow, "Pyrotritartaric and Carbopyrotritartaric Acids." 3. Mr. H. E. Armstrong, "Laboratory Notes." 4. Mr. E. Neison, "Octylic Alcohol and its derivatives."
Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Fifth conversazione.
Numismatic, 4, St. Martin's-place, W.C., 7 p.m. Annual Meeting.
Philosophical Club, Willis's-rooms, St. James's, S.W., 6½ p.m.

Fri.... ..Royal United Service, Whitehall-yard, 3 p.m. Discussion on the Naval "Prize," and other Essays on "Great Britain's Maritime Power; how best to Develop it."
Philological, University College, W.C., 8 p.m. Mr. Hy. Sweet, "The Classification of Words according to their Meaning."
Royal Botanic, Inner Circle, Regent's-park, N.W., 4 p.m. Prof. Bently, "The Classification, Properties, and Uses of Plants." (Lecture VII.)

Sat.......Physical, The Science Schools, South Kensington, S.W., 3 p.m. 1. Professor W. G. Adams, "Experiments with a New Polariscope." 2. Mr. W. Bailey, "Starch and Unannealed Glass under the Polariscope." 3. Sir Frederick Elliott, "Equipotential Surfaces of a Conductor under Influence." 4. Dr. Gorham, "Complementary Colours." 5. Prof. W. C. Unwin, "Flow of Water from Orifices at different Temperatures." 6. Mr. C. H. Hinton, "Co-ordination of Space." 7. Prof. S. P. Thompson, "Magnetic Figures, illustrating Electro-dynamic Relations."

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,335. Vol. XXVI.

FRIDAY, JUNE 21, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

FINANCIAL STATEMENT.

The following statement is published in this week's *Journal*, in accordance with Sec. 42 of the Society's Bye-laws:—

DOMESTIC ECONOMY CONGRESS.

Members of the Society, and Delegates from Institutions in Union with the Society, wishing to attend the Congress on Domestic Economy at Manchester, on the 26th June and following days, should make immediate application to the Secretary of the Society for tickets. Only two Delegates from each Institution can be admitted free.

PARIS EXHIBITION ARTISAN REPORTS.

The following contributions have been received since the last announcement:—

	£	s.
The Builders' Association	21	0
The Worshipful Company of Mercers	52	10

TREASURERS' STATEMENT OF RECEIPTS, PAYMENTS, AND EXPENDITURE, FOR THE YEAR ENDING MAY 31st, 1878.

Dr.

	£ s. d.	£ s. d.
To Cash in hands of Messrs. Coutts and Co., 31st May, 1877	604 16 8	
Do. do. Secretary	11 7 2	
		616 3 10
,, Subscriptions received during the year from Members and Institutions in Union	6,243 6 0	
,, Life Contributions	294 0 0	
		6,537 6 0
,, Dividends and Interest		656 0 6
,, Withdrawn from deposit with Messrs. Coutts and Co. (Clothworkers' Company's Scholarship)		100 0 0
,, Examinations (Commercial, &c.):—		
Prince Consort's Prize (H.M. the Queen)	26 5 0	
Donation (Clothworkers' Company)	10 10 0	
,, (Mrs. Harry Chester)	9 0 0	
Fees, &c.	6 2 7	
,, Examinations (Technological):—		
Donation (Clothworkers' Company)	10 10 0	
,, (Salters' Company, 2 years)	21 0 0	
,, (G. N. Hooper, Esq.)	10 10 0	
		93 17 7
,, House and Office (receipts for gas)		50 13 0
,, Advertisements		1,603 4 4
,, Sales:—		
Journal	147 1 1	
Cantor Lectures	10 3 0	
Sewage Conference Reports	23 17 2	
Domestic Economy ,,	20 11 0	
Waste Post-cards	1 0 7	
Transactions	3 4 0	
		205 16 10
,, Donations to Artisans' Reports Fund (Paris Exhibition, 1878)		97 5 0
		£9,960 7 1

Cr.

	£ s. d.	£ s. d.
By House and Premises:—		
Rent, Rates, and Taxes	337 5 0	
Insurance, Gas, Coal, and House Charges	201 13 3	
Repairs and Alterations	565 11 4	
		1,104 9 7
,, Office:—		
Salaries, Wages, and Commissions	1,672 2 1	
Stationery and Printing	265 11 8	
Advertising	44 13 6	
Postage Stamps and Parcels	203 4 0	
		2,185 11 3
,, Library, Bookbinding, &c.		101 1 0
,, Conversazione		218 7 10
,, *Journal*, including Printing, Stamps, and Distribution		2,558 15 2
,, Advertisements		332 19 8
,, Union of Institutions, including Commercial Examinations, Prizes, Fees, Postage, Printing, &c.	583 8 0	
Prince Consort's Prize	26 5 0	
Technological Examinations, including Prizes, Fees, Printing, &c.	181 10 2	
		791 3 2
,, Clothworkers' Company's Scholarship (3 quarterly payments)		78 15 0
,, Sanitary Conference		266 1 11
,, Domestic Economy Congress		193 9 0
,, Medals:—		
Albert	34 16 0	
Society's	27 3 0	
		61 19 0
,, Domestic Economy Syllabus Prizes		31 10 0
,, Cantor Lectures		276 2 3
,, Juvenile Lectures		21 16 6
,, Sections —		
African	71 3 0	
Chemical	62 2 6	
Indian	75 15 0	
		209 0 6
,, National Training School for Music, including Society's Scholarships (£160)		175 7 5
,, National Training School for Cookery		17 0
,, Committees:—		
General	12 13 8	
Blowpipe Prizes	13 0	
Drill	6 12 0	
Food	7 8	
		20 6 4
,, Subscriptions returned (paid in error)		4 4 0
,, Annuity to Mrs. Cantor		25 0 0
,, Artisans' Reports on Paris Exhibition, 1878		1 8 7
,, Cash in hands of Messrs. Coutts and Co., 31st May, 1878	785 6 1	
Ditto in the Secretary's hands	16 15 10	
		802 1 11
		£9,960 7 1

Liabilities.

	£	s.	d.	£	s.	d.
To Sundry Creditors	1,329	17	0			
,, Rates	41	13	4			
,, Prince Consort's Prize	26	5	0			
,, Examiners' Fees (Commercial, &c.)	168	0	0			
,, Ditto ditto (Technological)	78	15	0			
,, Examination Prizes (Commercial, &c.)	162	10	0			
,, Ditto ditto (Technological), estimated at	140	0	0			
,, Clothworkers' Company's Prize (balance due)	26	5	0			
,, Sir Walter Trevelyan's Prize	100	0	0			
,, Sections:—African, Chemical, and Indian	185	0	0			
,, Blowpipe Prize	10	10	0			
,, Repairs to roof	295	13	1			
,, Sanitary Congress	50	0	0			
,, Donations to Artisans' Paris Reports Fund	97	5	0			
				2,711	13	5
By Balance of Assets over Liabilities				5,841	7	0
				£8,553	0	5

Assets.

	£	s.	d.	£	s.	d.
By Society's Funds invested in—						
Reduced 3 per Cent. Stock £3,441 19s. 7d., viz., £3,176 7s. 6d., less £571 12s. 6d. reserved to meet Trusts stated below	2,604	15	0			
Great Indian Peninsula Railway 4 per Cent Debenture Stock	200	0	0			
				2,804	15	0
,, Subscriptions of the year uncollected	867	6	0			
Arrears, estimated as recoverable	400	0	0			
				1,267	6	0
,, Barry's Pictures and other property				2,000	0	0
,, Prince Consort's Prize				26	5	0
,, *Journal*, by Advertisements*				1,552	12	6
,, Cash in hands of Messrs. Coutts and Co., 31st May (including £97 5s., Donations to Artisans' Paris Reports Fund)	785	6	1			
Ditto on Deposit	100	0	0			
Ditto in hands of Secretary (Petty Cash)	16	15	10			
				902	1	11
				£8,553	0	5

* A portion of this sum is still subject to charges for printing, &c.

P. Le Neve Foster, *Secretary.*

Stocks and Cash Standing in the Name of the Society.

	£	s.	d.
Consols	£4,891	6	4
New 3 per Cents	388	1	4
Reduced 3 per Cents.	3,441	19	7
United States 5 per Cent. Funded Bonds, 1871 (2,500 dollars)	509	1	3
Oude and Rohilcund Railway 5 per Cent. Guaranteed Stock	2,150	0	0
Bombay and Baroda ,, ,, ,, ,,	2,450	0	0
Canada 4 per Cents.	423	0	0
India 4 per Cents.	105	18	7
Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock	2,170	0	0
Metropolitan 3½ per Cent. Stock	343	14	3
Cash in hands of Messrs. Coutts and Co., on deposit	100	0	0

Trust Funds Included in the above.

	£	s.	d.	
1. Dr. Swiney's Bequest	£4,500	0	0	Consols, chargeable with a sum of £200 once in five years.
2. John Stock's Trust	100	0	0	,, ,, the Award of a Medal.
3. Benjamin Shaw's Trust for Industrial Hygiène Prize	133	6	8	,, ,, ,, Interest as a Money Prize.
4. North London Exhibition Trust	157	19	8	,, ,, ,, ,, ,, ,,
5. Fothergill's Trust	388	1	4	New 3 per Cents., chargeable with the Award of a Medal.
6. J. Murray, Esq., in aid of a Building Fund	50	0	0	Invested in Reduced 3 per Cent. Stock.
7. Subscriptions to an Endowment Fund	431	12	6	(Invested in Reduced 3 per Cent. Stock.)
8. Dr. Aldred's Bequest	90	0	0	(Invested in Reduced 3 per Cent. Stock.)
9. Thomas Howard's Bequest	500	0	0	,, ,, United States 5 per Cent. Funded Bonds, 1871.
10. Dr. Cantor's Bequest	5,052	19	8	,, ,, Bombay and Baroda and Oude and Rohilcund Guaranteed Railway Stock.
11. Owen Jones' Memorial Trust	400	0	0	,, ,, Canada 4 per Cent. Stock.
12. Mulready Trust	109	12	9	,, ,, India 4 per Cent. Stock.
13. Alfred Davis's Bequest	1,800	0	0	,, ,, Great Indian Peninsula Guaranteed Railway Debenture Stock.
14. Memorial Window Fund	345	0	0	,, ,, Metropolitan 3½ per Cent. Stock.
15. Sir Walter Trevelyan's Prize	100	0	0	In Deposit with Messrs. Coutts and Co.

The Receipts of the Society set forth above have been credited by Messrs. Coutts and Co.
The Payments set forth above have been made by authority of the Council.
The Assets, represented by Stock at the Bank of England, and securities, cash on deposit, and cash balance at Messrs. Coutts, as above set forth, have been duly verified.

Edward Brooke,
H. Reader Lack, } *Treasurers.*
J. Oldfield Chadwick, *Auditor.*

Society's House, Adelphi, 19th June, 1878.

ANNUAL GENERAL MEETING.

The One Hundred and Twenty-fourth Annual General Meeting, for the purpose of receiving the Council's report and the Treasurers' statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new members, will be held, in accordance with the Bye-laws, on Wednesday next, the 26th of June, at 4 o'clock p.m.

A balloting list for the election of officers is forwarded to members with this *Journal*. No list can be received which is not presented in person at the meeting, and those members only are entitled to vote whose subscriptions are not in arrear.

By order,
P. Le Neve Foster, *Secretary.*

18th June, 1878.

EXAMINATIONS, 1878.

The list of successful candidates in the Examinations for the present year (the Technologica

Examinations excepted) has been printed, and is forwarded to the Institutions in Union with the present number of the *Journal*. Copies will also be sent to the various Local Boards for the successful candidates.

The results of the Technological Examinations will be published as soon as it is known whether the candidates have obtained the necessary certificates from the Science and Art Department.

SOCIETY OF ARTS EXAMINATIONS.

Report of the Educational Officer.

To the Council of the Society for the Encouragement of Arts, Manufactures, and Commerce.

Gentlemen,—In my report for this year I have not, as was the case last year, to record any important change in the system of examinations carried on by the Society. In 1876, considerable alterations were made; alterations which sufficiently approved themselves in their results, for the falling off in candidates, apparent in 1876, was checked, and a very decided increase was shown in 1877, the first year after the alterations were effected. It is gratifying to observe that there is still a decided growth, for the number of candidates this year is more than 150 in excess of the number last year, without counting the large increase in the Technology division.

Since the examinations were first set on foot, in 1856, they have undergone various modifications, and it may perhaps not be undesirable to take this opportunity of briefly passing in review their present condition.

The Society now examines and awards certificates in seven separate classes or divisions; in the eighth (Elementary) it merely supplies the Examination papers. These divisions are as follows:—

I.—Commercial Knowledge.
II.—Domestic Economy.
III.—Fine Arts applied to Industry.
IV.—Knowledge of Public Museums.
V.—Music.
VI.—Blow-pipe Analysis.
VII.—Technology of Arts and Manufactures.
VIII.—Elementary.

No. I., "Commercial Knowledge," comprises the following subjects:—1. Arithmetic. 2. English (composition and correspondence, extra marks being given for précis writing). 3. Bookkeeping. 4. Commercial Geography and History. 5. Shorthand. 6. Political Economy. 7. French. 8. German. 9. Italian. 10. Spanish.

This division, as its name implies, is intended more especially for the benefit of those engaged in commercial employments.

These examinations may be considered the principal of those held by the Society, and they attract by far the largest number of candidates. They are conducted by Local Boards, formed for the purpose, and connected with the Society of Arts. The Local Boards are generally connected with an institution "in union" with the Society, in which case the subscription of the institution covers that of the Board. Boards not so connected pay a fee of one guinea a year. Members of affiliated institutions are examined free; other persons pay a fee of 2s. 6d. The papers are sent down in separate envelopes to the Secretary of the Board immediately before the day of the examination, and the envelope containing the papers for each evening is opened by a member of the Board, in the presence of the candidate, on that evening. A number is allotted to each candidate by the Society, and he is known by that number through the examination. Care is taken to ascertain beforehand the precise number of papers required at each centre, and only that number is sent. The worked papers are sealed up at once, and despatched to the office of the Society. The arrangement requires to be carefully and precisely followed out; but, by the adoption of a system of checks, and by the exercise of a certain amount of care, it is found that mistakes very rarely occur.

Certificates of two classes are awarded. In order to obtain a "Certificate in Commercial Knowledge," a candidate must pass in three subjects at least, two of which must be Arithmetic and English. Candidates who pass in one or more subjects, but who do not obtain such a certificate, receive single certificates, which count towards the certificate in Commercial Knowledge.

Two prizes, a first of £5 and a second of £3, are awarded in each subject, and in many of the subjects an additional prize of £2 is offered for females only; additional prizes are also offered for Hand-writing, and Writing from Dictation.

No. II., "Domestic Economy" comprises four subjects; 1. "Clothing and its Materials." 2. "Health." 3. "Housekeeping and Thrift." 4. "Cookery." These examinations were established in 1876, so that at present we have only three years' experience of their working.

No. III., "Fine Arts applied to Industries," was also started in 1876, and has not as yet attracted any candidates. It is "intended to apply to subjects which are not at present included in the Art Examinations of the Science and Art Department, and especially to test a general knowledge of decorative art applied to Industries."

No. IV., "Knowledge of Public Museums," is also one of the subjects added in 1876, and the present year is the first in which any candidates have come forward. The object of these examinations is to "encourage the study and acquirement of a knowledge of the technical value of objects in any Public Museums and Collections in any part of the United Kingdom." There is no limit to the age of candidates, and the artisan class is especially invited to compete.

No. V., "Music," comprises two heads: "Theory of Music" and "Practical Examinations in Music." Examinations in the Theory of Music have been held for many years with the exception of one year, 1876. This subject includes, besides Harmony and Counterpoint, "Musical History and Biography." The proposal for instituting a practical examination in Music was only made the year before last, when it was announced that if a sufficient number of candidates presented themselves in any locality where a convenient centre of examination could be arranged, the Council would organise such an examination.

Although last year several candidates came forward, yet there were not enough at any one

centre to justify the Council in sending down their Examiner, and the same may be said for this year. There are, however, classes now in formation in different parts of the country, and it is confidently expected that before long the advantages of this proposal will be recognised, and that the list of candidates will be well filled.

In the above divisions (Nos. II. to V. inclusive) the examinations, with the exception of the practical examination in Music, are conducted at the same time and in the same manner as those in Commercial Knowledge.

No. VI., "Blow-pipe Analysis," is another recent addition, the examination having only been held twice as yet. These examinations arose from a suggestion by Dr. Clement Le Neve Foster, who, in the course of his duties as Government Inspector of Mines, had had occasion to notice the comparatively small use of the blow-pipe among English mining engineers, as compared with those of Germany. Prizes to the amount of £10 were offered for proficiency in qualitative blow-pipe analysis. Though the examination was open to any person presenting himself, it was held at Redruth, as it was intended principally for those interested in mining industries.

In 1877, nine candidates presented themselves, and of these, three passed sufficiently well to deserve a certificate, the first and second also being awarded prizes. The examination was entirely practical, the candidates being tested in their actual skill with the blow-pipe. In this, as in the Technological Examinations of the Society, the candidates were required to have taken a certificate in the Science and Art Department examinations. The subjects required were Inorganic Chemistry and Mineralogy.

No. VII., "Technology of Arts and Manufactures," was commenced in 1873.

In the first year's programme there were five subjects—Cotton Manufacture, Silk Manufacture, Paper Manufacture, Steel Manufacture, and Carriage-building. In 1874, the five subjects above-mentioned were retained, with the addition of four more, Cloth Manufacture, Glass-making, Pottery and Porcelain, and the Manufacture of Gas. In 1875, five more were added. Agriculture, Silk Dyeing, Wool Dyeing, Calico Bleaching Dyeing and Printing, and Alkali Manufacture. Agriculture was omitted on its being included in the list of the subjects of the Science and Art Department Examination.

It will be observed that in the first year, with five subjects, three of them were taken up, the number of candidates being only six. In the second year, with nine subjects, five of them were taken up, and the total number of candidates increased to thirty-six; in the third year, with fourteen subjects, eight of them were taken up, and the number of candidates advanced to forty-six; in the fourth year, seven subjects were taken up by sixty-two candidates; and in the fifth year, eight subjects by sixty-eight.

These examinations are held in connection with the May examinations of the Science and Art Department, the Technological papers being given out with those of the Department. Before a candidate can obtain a certificate from the Society of Arts he must have passed the Department examination in certain specified science and art subjects, varying according to the Technological subject taken up. The certificates are of three grades—Elementary, Advanced, and Honours—corresponding with those of the Department examinations. There is no examination in practical skill, but this is considered to be guaranteed by means of a report which the candidate is expected to obtain from his employer.

The following prizes are offered in each of the subjects to such candidates only as obtain First-class certificates:—To the best candidate in Honours, £10. To the best candidate in the Advanced Grade, £7. To the best candidate in the Elementary Grade, £5.

Special additional prizes are offered in some of the subjects, and a Scholarship of one hundred guineas, offered by the Worshipful Company of Clothworkers in the Manufacture of Cloth, was awarded last year.

No. VIII., "Elementary," are conducted entirely by the Local Boards. The Society of Arts supplies printed papers and forms of certificate, but takes no other part in the conduct of the examinations.

We may now turn to the results of the present year's examinations, and here it is satisfactory to note a decided increase in numbers on last year and the year before. The number of candidates in the first five divisions examined was 1,330, as against 1,185 in 1877, and 974 in 1876. Of these, 902 passed and 428 failed, the corresponding numbers last year being 801 and 384. Thus, not only are the actual numbers larger, but the proportion of successful candidates is slightly improved. The number of papers worked is also increased in a slightly greater ratio than the number of candidates, for the 1,330 candidates worked 2,094 papers in all, against 1,776 worked last year by 1,185 candidates. The increase, too, seems to be distributed pretty evenly among all the subjects.

In only two subjects is there an actual falling off, and the decrease is so slight that it may fairly be classed as due to the natural fluctuation from year to year. The largest increase in any one subject is in Commercial Geography and History, in which the number of candidates has mounted up from 31 to 92. The subjects comprised under the head of Domestic Economy have also attracted a larger number of candidates, for 170 papers were worked in them as against 94 last year.

It is somewhat remarkable that the examination in the Application of the Fine Arts to Industry has not as yet attracted any candidates, and it is certainly to be regretted that a subject so important and so closely connected with the special work of this Society should not receive more attention on the part of those engaged in the artistic industries of the country.

Four candidates offered themselves for examination in the Knowledge of Public Museums, and thus a beginning has been made. There can be little doubt that in this important subject the numbers in future years will increase.

The number of prizes awarded is larger than usual. Thirty-six have been given in the Commercial subjects, eight in the Domestic Economy, and two for the Knowledge of Contents of Public Museums.

The Prince Consort's Prize of twenty-five guineas,

graciously placed by her Majesty at the Council's disposal each year, has been awarded to George William Irons, of the St. Stephen's (Westminster) Evening Classes, who has gained nine first-class certificates with two prizes during the specified period. F. J. Arnold, of the Birkbeck Institution, has also obtained nine first-class certificates, and the Council had, therefore, to consider "the ability shown by the candidates in the examinations generally," in making the award. Mr. Arnold's certificates will, it is satisfactory to know, all be available for next year's prize, as they have been gained during the past three years, and the limit of time during which they can be counted towards this prize, is four years. The Council has also awarded the prize for female candidates, which has been gained by Emma Dickes, of the Birkbeck Institution, who has obtained three first-classes, with one prize during the specified period.

The examination in Qualitative Blowpipe Analysis was carried out at Redruth on Tuesday, the 4th inst. There were only ten candidates, and seven of these failed. The names of the three who passed are, in order of merit:—1. Cornelius Beringer. 2. William Rich, jun. 3. James George Nicholl. The last has not yet passed the Science and Art Department Examination in Inorganic Chemistry, and, consequently, is not entitled to receive a certificate of proficiency. The two others are properly qualified. The first prize of £5 was awarded to C. Beringer. The second and third prizes were not awarded.

Although the results of the Society's Technological Examinations are not yet known, the number of candidates can be given, and it will, doubtless, be a great satisfaction both to the Council and to the munificent City Guild which came forward last year to assist them, to notice how greatly those numbers have increased. It will be remembered that last year the Clothworkers' Company voted "a sum not exceeding two hundred guineas, for the purpose of paying the Teachers of the Students who may be successful in the Technological Examinations of the present year, on the same scale as Science Teachers are paid under the regulations of the Science and Art Department." This was duly announced to the Local Boards, and to the Science Teachers acting under the Science and Art Department, the result being that the number of candidates has risen from 68 to 184, an increase important both as pointing out the direction in which future results may be hoped for, as well as in itself marking very considerable progress. It appears that the offer of payment on results has led to the establishment by teachers of several special classes for instruction in the Technological subjects, and it is probable that only in this way can the number of candidates ever be greatly augmented.

It may, perhaps, be a matter for regret that no proposal for a system of Technological Examinations has been made in the recent report of the Executive Committee of certain of the Livery Companies of London, which has been for some time engaged in preparing a scheme for the establishment in London of an Institution for the Technical Training of Artisans.

The Council of the Society have always looked forward to the time when they might transfer these examinations to some special body, with more ample funds and better opportunities for carrying out the work. The report, which recommends the establishment of a Central Technical Institution and a number of affiliated Trade Schools, does, indeed, say that "Examinations would be periodically held in the central institution as well as in the trade schools, prizes would be awarded, and certificates of merit would be issued in connection therewith," but it does not in any way advocate such an extension of the system founded by the Society of Arts as those had hoped who first suggested its establishment.

It may, however, be hoped that the increased number of candidates this year will be sufficient encouragement to induce others of the rich City Guilds to follow the example of the Clothworkers' Company and assist in giving the experiment a fair trial. It is evident that without the hope of payment on results, teachers will not get up classes in the technological subjects, and that without such classes, artisans have no means of qualifying themselves for this examination. The first year that such payments are promised we find an immediate result. In one or two more years the numbers ought to be very largely augmented. If they do not prove to be so, on trial, it will be necessary to consider in what way the system is at fault, but till such extended trial has been made, it cannot be said that our technological examination scheme has ever had a fair chance of establishing itself.

It is to be noticed that a new subject has been added, the very important one of Telegraphy, and in this, notwithstanding very short notice, 17 candidates have offered themselves. Next year the list will be still further extended by the addition of Photography. The Photographic Society has voted the sum of £7 towards a prize in that subject, and in accepting this the Council resolved that next year the subject of Photography should be included in the Technological Examinations.

The actual numbers of candidates are given in the table, which shows the numbers for each year. The principal increase has been in Steel, there being 103 in this one subject, out of the total 184 in all subjects.

	1873.	1874.	1875.	1876.	1877.	1878
Cotton manufacture ……	1	10	13	19	17	28
Paper ……………………	—	—	—	—	—	—
Silk ……………………	—	—	—	—	1	—
Steel……………………	2	14	16	26	28	103
Carriage-building ………	3	3	4	3	2	2
Manufacture of Pottery and Porcelain ………	—	—	1	—	—	—
Gas manufacture ………	—	7	6	10	11	15
Glass ……………………	—	—	—	—	—	—
Cloth ……………………	—	2	3	2	1	—
Agriculture ……………	—	—	2	—	—	—
Silk-dyeing……………	—	—	—	1	—	—
Wool-dyeing ……………	—	—	1	1	2	4
Calico-bleaching, dyeing, and printing ………	—	—	—	—	—	—
Alkali manufacture ……	—	—	—	—	6	15
Telegraphy……………	—	—	—	—	—	17
Totals ……………	6	36	46	62	68	184

The increase in the number of candidates in these Technological Examinations, now becoming a most important branch of the Society's system, is most encouraging, and on the whole I may say that the results of the Society's examinations this year are more satisfactory than on any former occasion.

I have the honour to be, Gentlemen,
Your obedient servant,
CHARLES CRITCHETT, *Educational Officer.*

TABLE I.

RESULTS OF THE EXAMINATIONS OF 1878.

NAME OF LOCAL BOARD.	No. of Candidates Examined.	No. of Candidates who Passed.	No. of Unsuccessful Candidates.	No. of Papers Worked.	No. of First-classes obtained.	No. of Second-classes obtained.	No. of Papers not Passed.	No. of Commercial Certificates awarded.	No. of Prizes awarded.
Aberdeen	71	51	20	95	20	47	28	7	1
Aldershot	17	10	7	42	4	11	27	...	...
Ashford	3	2	1	4	...	2	2	...	...
Bacup	19	9	10	33	1	14	18	2	...
Belfast	10	7	3	18	3	10	5	1	...
Birmingham, High School	8	5	3	11	2	4	5	...	..
,, and Midland Inst.	96	65	31	115	15	59	41	1	1
Bolton, Church Institute	23	3	20	23	1	2	20	...	...
,, Mechanics' Institution	8	6	2	12	4	4	4	...	...
Brighton and Hove, School of Science and Art ...	16	12	4	16	8	4	4	...	...
Burnley	16	13	3	32	11	14	7	1	...
Cardiff	13	10	3	21	2	12	7	1	1
Carlisle	18	16	2	26	9	12	5	2	1
Carmarthen	3	3	...	3	...	3	...	...	...
Crewe	4	2	2	11	1	5	5	...	...
Dudley	3	2	1	3	...	2	1	...	...
Freetown	1	...	1	1	...	...	1	...	...
Gartsherrie...	43	24	19	43	5	19	19	...	...
Glasgow, Anderson's University...	47	27	20	49	9	18	22	...	1
,, Athenæum	41	28	13	51	8	24	19	...	3
,, United Young Men's Christian Assoc. ...	25	15	10	32	2	17	13	1	...
Halifax, Working Men's College...	11	7	4	26	2	9	15	...	...
Huddersfield	12	5	7	17	5	1	11	...	...
Hull, Young People's Institute	95	63	32	124	14	64	46	8	...
Ipswich	1	1	...	2	...	2	...	...	...
Kineton	6	5	1	15	3	7	5	2	1
King's Lynn	20	8	12	20	4	4	12	...	...
Leeds, Young Men's Christian Assoc.	12	11	1	24	7	12	5	1	...
Leicester	21	8	13	23	...	8	15	...	...
Liverpool	39	27	12	66	20	22	24	4	2
London, Birkbeck Inst.	134	122	12	235	129	71	35	6	18
,, Bow and Bromley Inst.	13	3	10	14	2	1	11	...	...
,, City of London College	90	75	15	134	55	56	23	9	4
,, College for Working Women	11	10	1	20	3	10	7	1	1
,, Dunn's Tailors' Labour Agency Inst. ...	1	1	...	1	1	...	...	...	...
,, Holloway College	14	10	4	38	...	10	28	...	...
,, Islington Youths' Inst.	10	7	3	16	3	7	6	2	...
,, Kentish-town Literary Inst.	5	3	2	9	3	1	5	1	...
,, Polytechnic Inst.	11	8	3	27	5	11	11	1	1
,, Quebec Inst.	8	3	5	10	2	1	7	...	1
,, St. Stephen's (Westminster) Classes ..	8	5	3	17	8	6	3	...	6
,, Walworth Literary Inst.	12	4	8	12	1	3	8	...	...
,, Wandsworth (St. Anne's) Science Class ...	9	4	5	10	...	4	6	...	...
Macclesfield	2	2	...	8	3	5	...	1	...
Manchester	58	41	17	102	30	37	35	5	2
Milton Mount College...	59	59	...	173	23	91	59	4	2
Mossley	14	8	6	23	4	6	13	1	...
Newcastle, Church Inst.	2	1	1	2	1	...	1	...	...
Oldham	50	21	29	79	7	20	52	...	...
Penzance	7	6	1	14	1	9	4	...	...
Preston (Avenham Inst.)	1	1	...	3	1	2	...	1	...
Redruth	6	3	3	9	...	3	6	...	...
Rugby (Irton Cragg)	5	2	3	11	1	1	9	...	...
St. Helen's	6	5	1	9	2	6	1	1	...
Salford	26	13	13	32	5	13	14	2	...
Shipley, Salt Schools	1	1	...	4	3	...	1	...	...
Stevenage	14	9	5	32	3	11	18	1	...
Stockport Sunday School Society	2	1	1	3	...	1	2	...	...
Stourbridge...	8	4	4	15	2	6	7	...	...
Swindon	12	9	3	29	5	13	11	1	...
York	29	16	13	45	5	20	20	2	...
Totals	1,330	902	428	2,094	468	837	789	70	46

NUMBER OF LOCAL BOARDS, 61.

N.B.—The Prizes in Writing from Dictation, in Writing and Manuscript Printing, and for Handwriting generally, are included in the Prize column.

TABLE II.

Number of Papers Worked in each Subject in the Present and Three Past Years, with the Results for the Year 1878.

SUBJECTS.	1875.	1876.	1877.	1878. No. of Papers Worked.	1878. No. of First-classes obtained.	1878. No. of Second-classes obtained.	1878. No. of Papers not passed.
Commercial:—							
Arithmetic	459	518	524	579	137	163	279
English	..	333	366	428	29	333	66
Book-keeping	311	325	339	325	111	109	105
Commercial History and Geography ..	23	11	31	92	13	35	44
French	250	157	123	147	9	24	114
German	77	30	30	32	9	10	13
Italian	7	5	6	7	1	3	3
Spanish	30	9	7	24	9	10	5
Political Economy	33	17	24	46	13	18	15
Shorthand	..	66	77	74	9	25	40
Domestic Economy:—							
Clothing	..	10	16	28	23	3	2
Cookery	..	10	26	53	30	18	5
Health	..	8	35	60	6	19	35
Housekeeping and Thrift	..	9	17	29	19	8	2
* English Language	212	..	..	..	..	..	..
* Gardening	2	..	..	..	..	..	..
† Theory of Music..	154	..	155	166	48	57	61
Fine Arts	..	..	..	..	..	..	..
Museums	..	..	..	4	2	2	..
Totals	1,558	1,508	1,776	2,094	468	837	789

* Examinations in these subjects have been discontinued. † This subject was omitted in 1876.

EXAMINERS' REMARKS.

The Examiner in *German* says:—"Thirty-two candidates presented themselves this year at that examination, which is a slight increase on the number of candidates of last year. Fourteen candidates aspired this time to a first-class certificate; nine of these were successful, four obtained a second-class certificate, and one failed entirely. Of the eighteen candidates who tried for a second-class certificate, six only were successful. According to my opinion, the large proportion of failures must be attributed to the fact that many of those who present themselves for the above examination have so imperfect a knowledge of German that they would probably have failed to obtain even a third-class certificate under the old regulations. Candidates should remember what I have often had occasion to remark, that before attempting to make themselves acquainted with German commercial correspondence, they should possess a general knowledge of the language itself, and that even the mastering of all the technical expressions and phrases current in German commercial phraseology will not enable a man to write or translate a German commercial letter, unless he has acquired a sound knowledge of the grammar, and has had besides considerable practice in translating passages on general topics from and into German."

The Examiner in *French* says:—"The result of the French examination is somewhat disappointing, and again shows the want of adequate preparation. Out of 147 candidates 33 only have secured certificates, a proportion decidedly too small. It is fair, however, to state that the three best papers are excellent, and there is also this redeeming feature, that, of the 114 "not passed," no less than 62 have obtained from 30 to 50 marks, which, under the old regulations, would have entitled them to a third-class certificate."

The Examiner in *English* says:—"To avoid wholesale rejections I have left the standard low."

The Examiner in *Political Economy* says:—"The answers of the candidates to whom a first or second-class has been awarded show a good knowledge of political economy as taught in the standard English works, and intelligence in their application. The answering of some of those reaching a first-class is of high merit."

The Examiner in *Italian* says:—"The result of my examination is very satisfactory, and shows an improvement over last year's. The work in most cases evinced careful preparation. In one instance I am enabled to assign a high first-class certificate, the candidate having shown a sound knowledge of grammar, a ready command of vocabulary, and an acquaintance with Italian construction and idiom. Even those candidates who have been unsuccessful in obtaining a first-class have reached such a high number of marks as entitles them to a high second-class certificate."

The Examiner in *Health* has kept the standard low, but hopes next year to be able to raise it.

The Examiner in *Knowledge of Public Museums* speaks favourably of the best two papers sent in.

The Examiner in *Commercial History and Geography* says:—"The papers of this year prove that excellent

teachers are taking up, earnestly, the subjects of commercial history and geography. More work and better work than before has been done. The Examiner finds it necessary, however, still to urge upon teachers and learners the importance of a study of the relative distances of large seaports and commercial centres from London or from continental capitals. One tendency of trade is to seek the shortest and cheapest course between places of production and places of sale or of consumption."

The Examiner in *Clothing* says:—"I have been much pleased to pass so large a proportion of the increased number of candidates. The questions are better understood and answered than was the case at the former examinations, though I still have to complain of the very inferior patterns—whether diagram or cut in paper—sent in with what are really very intelligent—if somewhat lengthy—'essays' on the subject in hand."

The Examiner in *Music* says:—"One hundred and sixty-six candidates have presented themselves for examination. Of these I have been able to place 48 in the first-class, and 57 in the second. The remainder have not passed. Of these last it is fair to say that the papers are creditable, as far as they go; yet the acquirements of the writer have not been sufficient to enable them to attain the 50 marks—half the number—needed for even a second-class certificate. I am desirous of calling the attention of musical instructors to a matter in which many of the pnpils are very deficient. Their writing of musical notes, and even of words, is for the most part wretched. Instruction in musical caligraphy is as much a part of a course in the theory of music as any other; and pupils should be taught, not only what to write, but how to write it. Moreover, not only is the labour of the examiner enormously increased by the slovenly writing, so much of which comes before him, but candidates themselves are placed at a serious disadvantage by their own clumsiness, through overlooking errors innumerable which the picturesque clearness of musical notes imperfectly formed would often reveal to them at a distance."

The Examiner in *Writing, &c.*, says:—"The examination papers submitted to me, from which the best specimens of handwriting had to be selected, were generally fairly written. Over 100 papers were written legibly and well, and it was a task of considerable difficulty to make the final selection. It is gratifying to see that a habit of writing with extreme legibility, with short loops, without flourishes, with even thickness and spacing, is becoming popular in the institutions and schools connected with the Society. No other style of writing is so fitted for the requirements and duties of life. Writing which begins by being absolutely legible very soon becomes flowing and characteristic, and when it does this without the least sacrifice of clearness a thoroughly satisfactory style is attained. The specimens of printing were few in number and of moderate quality."

The Examiner in *Blowpipe Analysis* says:—"It will naturally be supposed by some persons that the large per-centage of failures is due to my having fixed a very high standard for the pass examination, but such is not the case. The candidate need only get 50 marks out of the total possible 100 in order to secure a pass. The results of the examination prove to my mind that there has been a great want of systematic teaching of the subject. The students have learnt many of the common tests, but have not been drilled by a regular course of blowpipe work. This is easily accounted for by the fact that there are no payments for results to induce teachers to carry on such a course. A science teacher who gives lessons in Geology, Chemistry, or Mineralogy, for instance, receives a grant of at least £1 for every successful pupil, and consequently he suffers a pecuniary loss if he devotes his time to what is to him an unprofitable subject, viz., Blowpipe Analysis. I think, therefore, that if part of the money set apart yearly by the Society of Arts for this subject were expended in small grants to teachers, more good would be done than by mere prizes to students. For instance, the £5 prize might be abolished, and a grant of 10s. offered to teachers for every pupil who passed. I believe that it wuld be sufficient to offer two money prizes of £2 and £1 repectively, and in addition half-a-dozen prize blowpipes, costing 5s. or 6s. each, for the next best students who had obtained more than two-thirds of the possible marks. Of course, if teachers were paid on results, the blowpipe classes would have to be conducted much in the same way as those of the Science and Art Department, *i.e.*, under the superintendence of local committees. I should suggest that a minimum number of lessons, such as 12, should have to be given before a teacher was entitled to a grant. I feel pretty sure that if some such scheme as this were adopted, the number of candidates and the number of passes at the blowpipe examinations would be very much larger, and much more real good would be effected. I am glad to remark that the sets of blowpipe apparatus brought by the candidates this year showed a marked improvement on those used 12 months ago. I noticed two of the Society of Arts prize apparatuses, and I expect that in future years they will be largely used by students who are working up for the blowpipe examinations."

HEALTH AND SEWAGE OF TOWNS.

The Conference was resumed on Friday, May 24th. The Right Hon. JAMES STANSFELD, M.P., in the chair.

Papers on the "Discharge of Sewage into the Sea" were read by **Mr. Henry Robinson, C.E.**, and by **Mr. Schoolbred**,

Dr. Domenichetti said that he came there with a view of eliciting the opinions of gentlemen in regard to the discharge of sewage into the sea. His remarks would apply more especially to a rising watering place on the coast of Lincolnshire. It had been recently decided that the sewage should not be discharged into the sea, the decision being based, as he conceived, upon erroneous grounds. Intermittent downward filtration was now occupying the attention of the authorities, and his opinion was, that in the first instance it was desirable to drain into the sea, inasmuch as the report of the Royal Commission on this subject went, he believed, to show how very desirable it was wherever opportunities and facilities were given for the purpose, and that it was preferable to all other methods. He might mention that this was a small and comparatively young rising watering place. They had obtained the consent and sanction of the Local Government Board, and the money was granted for an extensive system of deep sewage with a discharge into the fore-shore below water mark. It was conditional upon the sanction of the Court of Sewers, and there the obstacle occurred which prevented the fulfilment of the design. The Government had granted money conditionally upon their sanction, and they had issued a protest, and had refused their consent upon the pretence that the sea defences, which were under their charge, would be endangered by the penetration of a 12-inch iron pipe, which formed a necessary part of the sewage scheme. He thought that this was a great mistake. The expenses of the undertaking had been calculated to be no more than £1,800. The plans had been admirably carried out, and had been approved by the Local Government inspector, and that gentleman was an officer of the Local Government Board. He wished to bring before them the importance of employing an

officer who was a professional man. The scheme had received the sanction of Major Tritton, the inspector, but as he (Dr. Domenichetti) had already told them, it fell through entirely from the Court af Sewers refusing sanction on the ground that the defences of the sea would be endangered. The Court of Sewers had no suggestion to offer with regard to the drainage of the place, except that they should resort to intermittent downward filtration, which meant the purchasing of land, which was very expensive, and also the setting up of pumping engines, as they could obtain no outfall without expense. He should be very glad if some gentleman present would favour him with his opinion as to the relative value of the two methods proposed. The local authorities were very much perplexed, and he should be glad to carry down to the country an expression of opinion which might in some measure guide and regulate their future conduct.

A Member—Might I suggest, Mr. Chairman, in answer to the question put by that gentleman, that he should refer that matter to the local officer, who is so competent to advise him. He would be, probably, the best party to advise in the matter—the same gentleman that he speaks of as a really competent man.

Dr. Domenichetti, in answer to the last speaker, said that he might explain that that matter was already out of the local officer's hands. It had received the official sanction of the Government, and had been highly approved, but a technical objection had been raised by the Court of Sewers, whose authority all the gentlemen present would be quite ready to receive as the paramount authority. In fact, an Act of Parliament would be necessary to override it. It was a very serious matter, and would, probably, become a matter of discussion in Parliament as to the limit of the power given to courts of sewers. It had been out of the hands of this officer, whose conduct had been highly approved by the Government, and the ratepayers, were now reluctantly obliged to have to resort to a very expensive, and in his opinion, a very unnecessary procedure.

The Chairman said that he thought that the Conference was hardly disposed, as far as he gathered, to enter into any lengthened discussion at present upon this subject, because they were awaiting a discussion of subjects for which that day had been specially set apart. What he would, therefore, say to Dr. Domenichetti was that, if time afforded, they would return to the subject before the Conference closed, and if time was not afforded for that purpose, he (the Chairman) would be happy to discuss it with him privately.

Mr. Young asked if he might be allowed to put just one question with regard to the paper of Mr. Robinson. What was the expense of the chemical treatment of the sewage, in the way he proposed, to get it into the sea, and to put the water into the sea in a pure form so as not to be a nuisance? It might be desirable that towns generally should have some idea as to what the cost would be. That was a very important item to the ratepayers. He might say that their sewer outlet was placed on the extreme eastermost point of England. It was a point where, whether the tide ebbed or flowed, no inconvenience was in any way felt, and the sewage was carried away without a very heavy cost.

Mr. Robinson, in reply to Mr. Young, said that it was a very wide subject, and he was not sure that the Congress would be pleased to go into the question. He should be very pleased to give any information after the meeting was over if he was able to do so. As to the cost of the treatment of sewage, they all knew that it depended upon the flow per head, the quality of the sewage, and many other points which it was impossible for them to go into with refcrenee to any single place.

Mr. Alcock (Sunderland) said that in accordance with the views which he understood to have been expressed yesterday, and which had been fully discussed, to the effect that he should draw up a resolution bearing on the subject of the house drains, or the connection between the house and the sewers, he had drawn up the following resolution:—"That in the opinion of this Conference, the benefits to large towns of a well devised and effective system of sewers is very often entirely neutralised by the careless and improper way in which house drains in connection with such sewers are laid and connected with the waste pipes of the house; that all drains intended to be connected with the sewers of a sanitary authority ought to be made by such authority in the same way that house services are made by gas and water companies to their mains; that similar powers to those contained in section 37 of the 11 and 12 Victoria, 112; with corresponding duties should be conferred and imposed upon all local sanitary authorities." He had also intended, though he did not know that it was necessary, to propose:—"That the Society of Arts should be requested to urge these matters upon the Local Government Board either by deputation or otherwise." But perhaps that might safely be left in the hands of the Council of the Society.

The Secretary thought they had better add this further proposal to the resolution.

The Chairman concurred.

Mr. Alcock said that what he proposed to add with reference to that point was:—"That the Society of Arts be requested to urge these views upon the President of the Local Government Board by deputation or otherwise." He thought that this question was fully discussed yesterday, and he had already given expression to his views at some length, and therefore at present he would propose simply to submit the resolution, reserving to himself the opportunity of making any remarks if they should be required by the observations which might be offered upon it by any gentleman.

Mr. Turner, in seconding Mr. Alcock's resolution, said that he had had some little experience in connection with sewers. In the town in which he lived, the management of the drains was superintended by the authorities, and he thought that that was better than nothing; yet it would occur to anyone that, in a large town, the supervision could not be exercised in a strict manner. Frequently it was utterly impossible for the inspector to go round and thoroughly inspect the whole of the drains laid down in the course of the day, especially where drainage was going on very rapidly in the town. There was another matter, too, which would come entirely into the hands of the local authority, and that was the quality of the materials of which the drains were made. These were points in which the letter of a bye-law might be kept, while its spirit was evaded. He begged to thank Mr. Alcock for bringing this matter forward.

A Member asked whether there was any evidence before the meeting that the connections between the houses and the sewers were badly made. Under the Act of Parliament there was a man employed to see that they were properly connected. They were connected by the authority. So far as laying the drains from the house, he thought that it would be an improvement if those drains were laid by tho authorities themselves.

The Chairman—I may answer you. I think it is in evidence before this Conference, and before the preceding Conference, that new houses are built, and that drains from those houses profess to be connected with the sewer, and that when the roadway is opened to examine the condition of those drains, they are found not to be connected with the sewer at all. That is in evidence before us, and many other minor defects are also in evidence; but the great point of this resolution, and I wish the Conference to understand its importance, is this, that this would apply not merely to new houses,

There is the great point. I am asked, too, that the clause should be read to which this resolution refers. It is a clause of the Act 11 and 12 Vict. chap. 112, which was "An Act to consolidate and continue for two years and to the end of the then next Session of Parliament, the Metropolitan Commission of Sewers." It is the clause (s. 37) to which I referred yesterday, and it is an extremely comprehensive one. It is in these words—"And be it enacted, that all sewers, drains, watercourses, weirs, dams, banks, defences, gratings, pipes, conduits, culverts, sinks, vaults, cesspools, privies, reservoirs, engines, sluices, penstocks, and other works and apparatus for the collection or discharge of rainwater, surplus land or spring water, waste water, or filth, or fluid, or semi-fluid refuse of all descriptions, and for the protection of lands from floods or inundation within the limits of the Commission, shall be subject to the survey, order, and control of the Commissioners, according to the provisions, and subject to the regulations and restrictions of this Act." That clause is referred to because that carries with it the rest of the Act by reference. But to give some idea of the nature of the powers conferred, I had better, I think, in the first instance, show where the weakness of the present law is, and then how this law if extended to the country at large would remedy that weakness. Now, with regard to new houses, there is practically very little to find fault with in the law, and I will give you the best proof of it. I might, of course, refer to the various sections of the Statute of 1875, but a more practical course will be to ask your attention to a series of publications of the Local Government Board, entitled "Model Bye-laws," which they issue and which they recommend. I have all their model bye-laws here, and one of those, number 4, is "New Streets and Buildings," and I turn to page 32, and I find many regulations laid down in great detail, as to the construction of drains and the connection of those drains with the houses. Rule 60, "Every person who shall erect a new building shall cause the subsoil of the site of such building to be effectually drained by means of suitable earthenware field pipes properly laid to a suitable outfall whenever the dampness of the site renders such a precaution necessary. He shall not lay any such pipes in such a manner or in such a position as to communicate directly with any sewer or cesspool, or with any drain constructed or adapted to be used for conveying sewage." And similar but more detailed and stringent injunctions are contained in other regulations as to the communication of any of the pipes and drains of the houses with the outside drain leading to the sewer itself; for instance, in the 62nd Bye-Law. So that, I take it, here is practically proof, that in regard to new buildings, a local authority, if it chooses to adopt the model bye-laws issued by the Local Government Board, may, probably, efficiently and completely deal with the difficulty. And as, I suppose, before to-day is over, some gentleman, who is present, may handle the Local Government Board not in the tenderest way, and as I desire that it should be fully and freely criticised for the public good, I think it only right to draw your attention to the issue of those model bye-laws, which I take to be an instance of the Local Government Board doing precisely what such department ought to do. But now, how does this Commission of Sewers Act deal with the difficulty of existing buildings? Well it does so in this way, in clause 46. I will read the marginal note, I think that will be sufficient. I will read the text *in extenso* if you desire:—"After the issuing of the commission under this Act, no house to be rebuilt without proper drains." And then there is a second marginal note. It is this:—"If houses, built before the passing of this Act, are not properly drained, the Commissioners may order the same to be done." Therefore, there is no difference whatsoever under this Act between old and new houses as to the drains and connections coming under the control of the Commissioners of Sewers. The only want that I find in this Act, speaking from my recollection of it rather than from perusal of it this morning, is that I think it does not sufficiently distinctly impose a duty, and, therefore, I am glad to find in this resolution of Mr. Alcock, that he does not limit himself to propose that the powers of this Act should be conferred upon all local sanitary authorities, but that corresponding duties should be imposed upon them; and I hope that you will look at it from that point of view. Powers are not sufficient. You must impose duties, because a power may, or may not, be exercised. If a corresponding duty is not imposed, the probability is that the power will not be systematically and continuously exercised; and this particular power is of a value which will be useless in its exercise, if that exercise be not systematic and continuous. Practically speaking, it comes to this, if you have a well organised local authority, the local authority ought to have a complete set of maps of the whole underground sewage and drainage of the town, and of the connections with every house in the town, and every ratepayer ought to have a right to inspect those maps, and to be advised in case of need as to the condition of his own house, though, of course, he ought to pay the expense of putting his house drains in a proper state, if they are not so already. Nothing else than that, in my mind, will solve the problem. I see no objection to that. It is a simple business arrangement. Some people may start and shy at it, and say it is imposing too serious a responsibility, and conferring somewhat arbitrary powers. I look at it on the contrary, as a simple business arrangement for the good of society, and, if you will allow me to repeat an expression I used yesterday, a necessary arrangement, if the Legislature is to place the local sanitary authority in a condition to fulfil the obligations which that local sanitary authority itself incurs. The local sanitary authority calls upon the inhabitant ratepayers to drain their houses into its sewers; and by calling upon them to do so it undertakes a corresponding obligation of its own. And that obligation is a twofold one. First of all, it has to carry away successfully house refuse and sewage; and secondly, it is not to return it in that very dangerous and deleterious form of sewer gas into the house. Therefore, I very cordially approve of this resolution, and I hope it will meet the approval of the Conference.

A Member asked how far the regulation covered rural authorities? He apprehended not at all.

The Chairman—Yes, entirely. The resolution includes all local sanitary authorities.

The Secretary hoped that it would include the metropolis, because that was usually excepted from all sanitary arrangements, and it was more important, he thought, in the metropolis than in any other place.

The Chairman—We had better add the metropolis.

Dr. Wright (Cheltenham) said that it had been asked whether they had any evidence that those defective arrangements existed. A place had come under his own observation where they had spent £4,000 or £5,000 in laying out a system of sewerage, but there was no duty imposed upon persons to have the connections made by the sanitary authority. He had had several complaints, as medical officer in that district, of what they called a complete failure of the sewers, in consequence of the cheap rate at which some of the contractors made the connection. Some drains had been made in the wrong direction, so that instead of the sewage being carried into the drains without a proper fall, it went back into the house. It was one of the most important questions connected with the escape of sewer gas into the houses to have the connections entirely under the control of the sanitary authority. Persons objected, because they thought it was a monopoly, and that the matter was made simply to be under the surveillance of the surveyor; but many connections were made where no oversight

took place, and where the evil was not detected until the mischief had been done. He had had to look at this question for years, and he was very glad to see that the resolution had taken the present shape; it had his perfect support, because he thought it was one of the most important resolutions that had been submitted to this Council.

Mr. Cresswell asked Mr. Alcock if he intended that the duty should be compulsory and not permissive?

The Chairman said that he thought that Mr. Cresswell had better address the question of the interpretation of the resolution to the Chair. Undoubtedly, this resolution would impose a duty upon a sanitary authority, and the performance of that duty would be compulsory.

Mr. Cresswell said that he was much obliged to the President. The second question he wished to ask was whether all this was to be done by the sanitary authority at the cost of the sanitary authority, or whether it was to be done at the cost of the freeholder or the occupant?

The Chairman thought it was unnecessary to embarass themselves with that question. He did not mean that that question would not be easily answered, but it would, probably, make the resolution too long, and what they wanted was to assert the general principle that the control should be in the hands of the sanitary authority.

Mr. Cresswell said that that being so, he would not press the question. Of course he was in favour of further legislation, especially of compulsory legislation. He was going to make what might appear to be a somewhat discourteous criticism with reference to one of the phrases of the resolution, and that was the word "neutralise." He was not quite sure what the word "neutralise" meant. He did not wish to be hypercritical, but he thought the word "neutralise" was somewhat ambiguous. He would suggest an alteration, and that was:—"That the objects of the Act have been defeated."

The Chairman said that he did not wish the Conference to get into verbal discussion, but he had no doubt that Mr. Alcock would in some way meet Mr. Cresswell's view.

Mr. King (Mayor of Portsmouth), in support of Mr. Alcock's resolution, said that in his town they had the power of compelling the owners of property to see that their drains were in a proper condition, but had not power to do the work and charge the owner with the cost. In large towns very frequently, although the wishes of some of them might be to compel owners to join their drains to the main sewer, yet they had not the power to compel them to employ the local authority to do the entire work of connections and fittings; and, therefore, the majority of the inhabitants allowed these things to be done by private parties, and thus the evil, which Mr. Alcock had very properly complained of, was perpetuated. Those model bye-laws alluded to were all right enough, supposing they had no bye-laws of their own, but at Portsmouth they had bye-laws, and they could not now be amended without much difficulty. They wanted laws to make the owners of property connect the drain from the house to the main drain by the workmen of the local authority. He believed the connections and internal fittings were very often made in a very inefficient manner simply because the owners of property would employ cheap contractors, and thus sacrifice efficiency to false economy.

Mr. Hewson (Rochdale) said that he rose to support the motion, and to inform the Congress that much of the powers sought for by this resolution they had had in Rochdale for six or seven years, and he thought that they were almost as effective as the legislation suggested by the resolution. For instance, they had all drains laid by authorised contractors, exactly after the same manner as the gas and water companies.

The Chairman—Is that under the local Act?

Mr. Hewson said that it was. They had that power, and they used it very thoroughly. The net result to the ratepayer was a very great gain in point of cost, and the work, he was sure, was very much better done, for these authorised contractors worked under a printed list of duties, so termed, which each of them signed when he was put on the list of authorised contractors. Among these duties there was the responsibility that, if it transpired at any future time that work had been done defectively, the contractor was liable to be struck off the list, and if his charge was exorbitant, an appeal was made, and the office regulated the same. He thought that they got much better work done than under the ordinary way. With regard to drains, they were all under the survey and control of the Corporation. They had, in fact, a clause very similar to the one which the President had read. It was—"All branch drains, whether within or without the premises to which they belong, shall be under the survey and control of the Corporation, and shall be repaired or altered and kept in proper order at the cost of the owners." They had another clause which said that—"All drains, as to size and inclination, shall be under the approval of the Council." They had also another clause, which said that—"All drains should be ventilated and trapped, and wherever it could be avoided, no drain should be under a building." He mentioned these things as being contained in an Act of Parliament instead of in a bye-law. There was one very serious question connected with this matter. If it were made compulsory upon Corporations to alter drains at the expense of the owner of the property, would not the door be opened to litigation in cases of defects occurring in these drains? He wished to support the motion, but still that was a feature which it seemed to him would militate against Corporations wishing to get such an Act of Parliament as the one proposed.

A Member—Has any action been brought against your corporation?

Mr. Hewson—No; we do not lay them ourselves. The owners of the property are at liberty to employ any of the authorised contractors. Those contractors are not the servants of the Corporation, but they act for the owners.

Mr. Chadwick said that the purport of this resolution was to do generally or extensively what had already been done successfully in different localities, and done in a way which removed the objections of landlords and all others on the score of cost. It had been done by private improvement rates. Under that system (the working of which it was evident, from the discussion generally, had yet to be made known) in some thirty towns or more, the whole of the works, from the water main to the house service pipe and from the sink and soil-pan to the sewer, had been done by a public authority under private improvement rates. Supposing that the work cost some five or six pounds, instead of its being charged upon anybody in gross for immediate payment, there was simply an addition of four or five shillings made to the rate, and this rate the occupier paid as he had the benefit of the work. That plan was found to work exceedingly well, and to remove all those objections which might be raised. In this way the work was done at half-price. The occupier paid a penny a week or something additional in his rate for the convenience. He was the person who had to pay, and under those circumstances he did pay ungrudgingly. The persons who were offended by it were the plumbers and the private traders. The compulsory clause, he (Mr. Chadwick) begged leave to say, would be a great help to local authorities, who, when the matter was left permissive, were assailed by a number of persons having various interests, such as builders and plumbers, who said "You ought not to interfere with our trade." The compulsory power

would strengthen the virtue of the corporate bodies by enabling them to answer "We cannot help it; we must do it."

Lieut.-Col. Jones (Wrexham) said that he rose with great pleasure to support the resolution. He thought that if no other suggestion for improvement in legislation on sanitary matters was brought forward at this meeting, the Conference would have produced very useful results. His own observation led him to urge the resolution from the point of view of the gas and waterworks, the reason for making the connections in the case of gas and water being left in the hands of the companies, was that the gas and water were valuable matters which it was desirable to prevent from escaping, and, therefore, the common sense of requiring that the owners of those valuable matters should have the power of seeing that the materials, which they supplied to the householder, were not wasted, had ensured such powers being given to the gas and water authorities. There was a want of understanding with regard to sewage, either as a valuable substance in itself or as dangerous and a difficult substance, and, therefore, it was necessary to take care that it was properly dealt with. If the thing was viewed in that light, the parallel between the gas and water companies would become more evident than at first sight appeared. That was the light in which he had looked at the matter as a sewage farmer. He had felt that at the bottom the whole difficulty of sewage treatment was the excess of rain water and the uncertain quantity of rain water. He had put this both before the public and his own corporation so repeatedly that he would not go into it now. The resolution bore upon the powers of enforcing the proper treatment, because, although his Corporation had adopted a separate system with regard to all future sewage works in the town, still, when the sewers passed through very low-lying districts, where there was a great deal of rainfall, if the private owners had the power of turning all their rain water into the sewers through their house drains, the hope of keeping the rain water out by the adoption of the separate system by the sanitary authority was liable to be defeated. He thought that that was simply a matter of common sense that the private owners would see that it was to their interest that the Corporation should do the work, as they could do it more cheaply by a conjoint contract, under their own control, than the owner of the property could get it done. The Corporation could also see to their repairs in the same way. If repairs were wanted in water pipes, or gas pipes, everybody went to the company, or to one of the authorised contractors employed by the company. He thought that Mr. Hewson's suggestions in connection with Rochdale were very likely to meet the case. If there were authorised contractors under the control of the Corporations, the employment of them would answer as well as the Corporations themselves actually undertaking the work.

Mr. Holden (Hull) rose to express his entire approval of Mr. Alcock's resolution, and also his thanks to that gentleman for submitting it to them. He had hit the right nail. As a medical officer, the great evils which he (Mr. Holden) had had to contend with had arisen from the very imperfect and scamped way in which the drains were laid down, especially in new tenemental dwellings. He would fain hope that the resolution would lead to the making the matter compulsory upon Corporations. He believed that if sanitation was to go on successfully, and the Public Health Act was to work well, the word "may" must be turned into "shall" in many cases. Those who had to do with large towns were painfully aware of the fact, that a large proportion of speculating builders got into town councils. How was it possible to expect them to do what they would call cutting their own throats. He made this statement advisedly, for he knew that it was an evil which really existed. If this Conference resulted in nothing but the passing of this resolution, or, at all events, in causing it to go forth that they, as sanitarians, were alive to the importance of this question, he for one should return to Yorkshire thinking that he had done well in coming, and he should be very glad to come again.

Mr. Lawrence Hamilton said that though it might seem a somewhat ungraceful and ungrateful observation, he could not help thinking that the wording of the resolution, which they had now the honour to consider, was not, perhaps, as carefully or judiciously arranged as it might have been if Mr. Alcock had had more time to consider that wording. Although the resolution was read twice, he (Mr. Hamilton) was not able to follow it very clearly, and he thought that it would be a mistake to allude to any Act of Parliament in the resolution, for nobody could be supposed to carry Acts of Parliament in his head. He would suggest a somewhat different wording in substitution, but he had written it in a hurry, and, probably, it ought to be reconsidered, and no doubt the Council of the Society would put it into a far better form than that into which he was able to put it upon such short notice. He would venture to propose the following amendment:—"It shall be the compulsory duty of the local authority to take into their own power and to complete the system of house drainage, which shall be executed at the cost of the ratepayers or freeholders, as in each case may seem desirable to the said local authority." The reason for giving some power to the local authority, was that it had to consider two totally distinct classes of property. Thus, if a freeholder owned a large portion of a town, or a county, it would be perfectly fair to make him pay for the work. But if a man had only a very passing and a very small interest in the property in which he happened to reside, it would be more a matter which ought to be taken in hand by the ratepayers in general under the Improvement Act, which Mr. Chadwick had alluded to with so much clearness and precision. He would venture, in conclusion, to suggest that if the worthy Chairman, whose enormous experience and clear head had taken in hand so many things and mastered them, would amend the rough wording of the resolution, he (Mr. Hamilton) would feel very grateful. He wished it particularly to be understood that he did not offer those words as a final or complete resolution, but he wished that some considerable improvement in clearness and legal diction might be made in the wording of the resolution.

Mr. Wild suggested, for the sake of saving time, that the amendment put forward by the last speaker should be withdrawn. If the Conference were to enter upon a question respecting the different rights and liabilities of owners and ratepayers, which really did not touch the principles of the resolution before them, they might involve themselves in a discussion which would last until they broke up that evening.

The Chairman—I was about, not exactly to rule this amendment out of order, but to say precisely on that ground that I should not advise the Conference to entertain the amendment. It is not simply an amendment upon the resolution, but it is a new resolution, and it enters upon a new subject,—that is the subject of the distribution of cost; and though that is an important subject, we are not prepared to enter upon it now. As Mr. Lawrence Hamilton has rather appealed to me in this matter, I feel bound to say that I had some hand in this resolution, which has been moved by Mr. Alcock. Shortly before I took the chair it was shown to me, and, as far as the time would allow, I made one or two suggestions which may be seen in my handwriting upon the face of the resolution. I am perfectly free to admit that, if time afforded, a more perfectly phrased resolution might be put together, and I am also ready to admit that there is something objectionable, *prima facie*, in the reference to the clause of the Act of

Parliament, with which it cannot be assumed that every member of this Conference is entirely and sufficiently familiar. I admit, therefore, that if you take this resolution as it stands, you take it somewhat on the faith of the statement of Mr. Alcock and myself with regard to the contents of that Act of Parliament. His object in inserting that phraseology was to avoid a very lengthy and detailed resolution. If the Conference do not like to commit themselves to the approval of a particular section of a particular Act, however it may be recommended to them, then it is necessary to fall back upon some general phraseology, which may, without much difficulty, be discovered. I think it is a fair way of putting the matter.

Mr. J. M. Fox (Cockermouth) said that he had asked the permission of the President to address the Conference on this resolution, because it bore somewhat upon the very interesting discussion which they had yesterday, in which the advocates of the water-closet were rather severely handled by members of the Conference. The question had been asked, whether they had it in evidence that the resolution of Mr. Alcock was needed. He (Mr. Fox) should say, in answer to that inquiry, what the botanist said in answer to inquiries about the commonest plants, *vide passim*. He wished to give to the resolution his most earnest support on the ground that, if the powers which were embodied in that resolution were conferred on authorities, nothing would more effectually tend to remove the objections which were entertained by many persons, in the year of grace 1878, to the water-carried system. There was a good deal said about connections. His object in supporting the resolution would be that under its auspices connections would also be made disconnections. And that was, he believed, at the root of the great objections which were supposed to apply to the water-closet system. As to the particular matter to which their attention was invited in the amendment which had just been put forward, his view was that the original resolution was intended to express a principle, and not to go into details.

Mr. John Walsh (Halifax) said that he quite agreed with the view that more power ought to be given to local boards than they possessed under the present Act of Parliament. Although the town from which he came did not find much difficulty in carrying out the various works required by the Act, in consequence of the duty not being imperative, difficulties did occasionally arise. Persons who had experience in town councils and local boards would know that, when works of this character were optional, they were often left undone. Whatever system was adopted for disposing of the sewage, even if it was the most perfect system, so long as the gases could escape from the main sewers into the drain and get back into the dwellings, there would be an evil. If a plan could be adopted that would disconnect the drains outside the buildings, so as to allow of the escape of gases before the drains actually entered the buildings, that would be the best safeguard against the sewer gases penetrating into the houses. With regard to the power which was vested in local authorities, according to his experience, it ought to be more comprehensive and binding, and not only deal with new drains and new buildings, but also with existing drains which were unsatisfactory. In such cases the local authority ought to have the power to insist that the drains should be put into such a state that they should be satisfactory to the surveyor for the time being. If the local authorities did not have this duty imposed upon them, no doubt local influences would oftentimes be brought to bear upon those bodies in a way which would prevent works being carried out as efficiently as they ought to be.

Mr. Yeld (Sunderland) said that he thought that they were all pretty well agreed, from the discussion that they had yesterday, as to the desirability of carrying out a resolution of this description. He, in common with all other medical officers of health, was impressed with the evil effects of the present system and the need of reformation. The only thing which he wished to refer to was the question which had been raised by Mr. Cresswell, as to the cost being thrown upon the owners of the property. Of course the resolution, in one sense, affirmed that the work should be done at the cost of the owners. What he wished to say was, that not only would it be to the advantage of the public health that the house drains should be laid by the local authority, but also it would be for the pecuniary advantage of the owners. The Corporation could lay the drains at a much cheaper cost than that at which the owner himself could get them laid. Cases had come under his observation in which contractors had laid house drains, and had charged 50 per cent. more than they would have cost if the Corporation had laid them.

Mr. Woodward, of Worcester, said that with many of the observations which he had had the pleasure of listening to he very fully agreed. There appeared to him to be very great difficulty in dealing with the question in anything like the manner which was proposed by the gentleman who moved the amendment. But it would be very desirable if the local authority could have perfect control over house drains. All drains to be constructed in houses should, first of all, be submitted to a competent officer of the local sanitary authority, whatever that authority might be. In that case they would make the sanitary authority in one sense responsible for the perfection of the work. But he would also make it compulsory for the officer of the sanitary authority to visit all the houses which were drained, and to see that the work was perfectly completed. He regretted to say that he was so unwell that he could not attend the meeting yesterday; and, perhaps, he might be allowed to make one or two observations with regard to a matter of importance which was then discussed, which was the economical disposition of the sewage. He very much regretted that he could not be allowed to speak on that point, because it was a very important matter.

Mr. Ryder (Mayor of Devonport) rose for the purpose of supporting the original resolution, because he thought that an absolute compulsory power, and the requirement that sanitary authorities should do the work themselves, would only prove efficient. He knew the importance of this subject, in consequence of the practical experience of the last few months. Several houses, which had been built within the last three or four years, were examined in consequence of some suspicion, and it was found that they had not been connected with the sewer at all. But while such things occurred, all the apparent control which existed at the present time must plainly be insufficient. He believed that nothing but adopting the course referred to in the resolution would have any absolute effect.

The Chairman—With regard to Mr. Lawrence Hamilton's amendment, I think that the feeling of the Conference is that we can not take it precisely as it is framed, because it includes matters which we are not prepared, at this moment at any rate, to discuss. But there remains the broader question which he has raised—whether it is advisable to pass the resolution as framed, or to pass some amendment of the resolution, which should avoid reference to the Commission of Sewers Act. Mr. Alcock's resolution, which I thought it right to state I had some share in, is in these words:—"That in the opinion of this Conference, the benefit to large towns of a well devised and effective system of sewers is very often entirely neutralised by the careless and improper way in which the house drains connected with such sewers are laid, and connected with the soil and waste pipes of the house; that all drains intended to be connected with the sewers of a sanitary authority, ought to be made by such authority in the same way

that house services are made by gas and water companies to their mains, with similar powers to those contained in Section 37 of the 11th and 12th Victoria cap. 112 (the Commissions of Sewers Act); that corresponding powers and duties should be conferred and imposed upon all local sanitary authorities, and that the Society of Arts be requested to urge these views upon the President of the Local Government Board by deputation or otherwise." It would be well to introduce the words, "The Commissions of Sewers Act," after the words "chapter 112" in the resolution, and also to add the words "including those of the metropolis," after the words "all local sanitary authorities." I have asked a very competent man, Capt. Galton (and there can be none more competent), to be kind enough during the last few minutes to draft an amendment upon this resolution, if it should be the wish of the Conference to avoid a direct reference to the Commissions of Sewers Act. The amendment which he has prepared, is this. The first sentence of the resolution recites generally the opinion of the mischief consequent upon imperfect drains and connections. Then, according to Capt. Galton's amendment, you, first of all, have the general proposition that mischief results from the existing state of things, and then you would have a proposal that all there is between the house and the sewer may be made by the local authority; and then, instead of that reference to the Commissions of Sewers Act, you would have these words:—"That all soil and waste pipes in and about houses, intended to be connected with the sewers of the sanitary authority, should be executed under the direct control of that sanitary authority, including those in the metropolis, and that it should be the duty of the sanitary authority from time to time to inspect them, and to see that they are in due working order." The are the two alternatives; I think either of these ought to be acceptable to this Conference.

Mr. Chesshire wished to suggest, before the resolution was put to the meeting, that this proposition would apply to those towns only which were well sewered. He had yet to learn where the town was that was well sewered. It certainly was not the town in which they were assembled. Nor was it any town that he knew of. Under any circumstances if the solid excreta passed into the sewer, the town could not be well sewered, and he thought that it would be desirable to leave out that portion of the resolution which referred to the town being well sewered. Let it apply to all towns whether they were well sewered or not. He would suggest that a Commission should be appointed, similar to the Railway Commission or to the Rivers' Pollution Commission, which should have control over the supply of water to towns and over the disposal of town sewage; such a Commission would be a very important body, and should consist of an eminent engineer, an eminent medical man, an eminent agriculturist, and an eminent financier, for the subject possessed all the aspects which would be dealt with by men of those four classes.

The Chairman said that he did not think the phraseology of the resolution was open to the objection which had been urged by Mr. Chesshire, for he did not understand the resolution as saying that the systems of water-carried sewage in existence were well devised, but that, however well devised the system of water-carried sewage might in any particular instance be, its benefit was neutralised if the connections with the house drains were not properly managed.

Mr. Alcock said that perhaps it might save time if he pointed out the fact that his resolution was simply intended to affirm a principle, and then virtually to leave it in the hands of the Council, as one of the speakers had said, to urge upon the Local Government Board; therefore, all questions of detail and wording would be far better discussed by the Council afterwards. They might simply pass the resolution as it was at first submitted. He believed that almost every gentleman there seemed to agree in the desirability of that course being adopted.

A Member suggested, as an amendment to the resolution:—"That the size, material, construction, and erection of every sewer shall be under the control and direction of the sanitary authority; and that no drain shall be covered over until after 24 hours of its being made."

The Chairman—I think that I do not incorrectly gather the generally feeling of the Conference if I interpret it as being in favour of the resolution. Since I spoke I have made one slight alteration in the resolution, which, I think, will really meet any difficulty which may exist in any one's mind as to our being too much tied to the provisions of a particular Act. It seems to me perfectly clear that what this Conference desires and sees its way to, is the conferring as much power and duty as possible in those respects to the local authority. I propose to alter the resolution by inserting the words, "powers as extensive as those conferred;" so that, you see, if, on closely examining the Commissioners of Sewers Act, we should find that there was any little deficiency in the powers conferred, as well as in the duties imposed, it will be open to us to remedy and to supply that deficiency. Well, unless anyone wishes to insist upon proposing an amendment, I shall put the resolution to the Conference.

The motion was then submitted to the meeting, and carried unanimously.

The Chairman—The next subject which we had better open before we adjourn is—"Whether any further legislation of a compulsory or permissive character is needed for bringing about a better sanitary condition of towns or dwellings, or any change in imperial administration."

A paper on "The Necessity of Further Sanitary Legislation, and the Progress, if any, made in Treating Water-carriage Sewage" was then laid before the meeting by Mr. C. M. Cresswell.

Sir Henry Cole—You may imagine that, when I am going to say a word or two as advocate of the Local Government Board, I shall not occupy your time more than ten minutes. The Local Government Board was invented in order to help the people to get better health; but we cannot expect governments to be wiser than the people themselves. We must accept that as a first principle. Our political system may bring to the summit some exceptional people; but if they are to administer for the health of the people, they must know what the people want, and get experience and knowledge from their views. Now, undoubtedly, the Local Government Board helps us a little in this way. I am bound to say, with regard to this question of irrigation, being a question in which I have taken some interest, that in the last report of the Local Government Board, no doubt prompted a little by the Society of Arts, they are following the lead of the Society, which is wise. Well, I give them credit for that; but I do not think that they ought to stop there, I do not think that it is the business of the Society of Arts to do the imperial Government's work in this question. You will observe that when they give this nostrum—an old-fashioned nostrum, indeed, which a former speaker has treated with the contempt it merits—irrigation—is it still their only nostrum for keeping rivers from being polluted. But we must give the Local Government Board credit for having at last got some doubts upon the subject themselves. For instance, take the report of two years ago, by Mr. Rawlinson, who, no doubt, much influences his masters, and who has done a great deal in this direction, but, like myself, is rather old, though we cannot help that. It is astounding how the Board can have the boldness to write what Mr. Cresswell has quoted, when they issue

the report signed by Mr. Rawlinson and Mr. Clare Sewell Read. In the eighth paragraph, page 13, they say, "that land irrigation is not practicable in all cases, and, therefore, other modes of dealing with sewage must be allowed." You have heard mentioned a dozen cases—I could mention a great many more—where the only answer they have to give is, "If you do not go to land and irrigation now, we shall compel you to go to it at some future time." I know a recent remarkable case, where one of the most eminent engineers of the day made a thoroughly practical scheme for dealing with the sewage of the town, and, after it had been completed, the answer they got from the Local Government Board was of that kind. The scheme was stopped, and, as Mr. Cresswell said, "They shove down your throat this nostrum of farming and irrigation. The things are mixed up together, and nothing is perfect except those two. By this means," my authority said, "you grow cabbages at sixpence to sell at a penny, and poison your neighbours with the stinks." Well, I think that we may maintain that the only function of the Local Government Board, in the present state of matters, is impartially to collect and publish all the information that they can collect, and not act as a Pope. The Registrar-General of Births and Deaths can tell us how many people die, and he gets into the question of health besides, and he gives statistics, and the facts come out, as a matter of course. Why should not this Government Board do the same? Why should not they tell us annually and in detail what the people are trying to grope their way into? Instead of that, they have made but a little beginning, and we must give them due credit for it; but why should not this come out systematically? One of the smallest points to come before this Congress came before us yesterday, and it is not out of court now. It is the question of the collection of excreta. Why should not the Government Board tell us all that is going on in this country, and the various experiences of towns in this country year by year. You will see how I will illustrate that point. Allow me to call attention to the simplest form of pail; and if the Local Government Board knows about it the Society may give them a silver medal. There is a great question on carrying this matter about towns, and patents are taken out for covers, more or less costly. I venture to say that not a single soul in the Local Government Board knows what Warrington has been doing. Now, in Warrington is a plain tub, which costs a few shillings, instead of any intricate method of india-rubber and iron, and the other contrivances for keeping filth from spilling. At Warrington they do nothing but have a piece of wood on the top of the pail. It is so simple that they ought to take out a patent for it. I have seen the whole thing at work. They put a cloth over the pail, and then they put this wood cover on the top of it, and they get no spill anywhere; and then they wash the cloth and wash the pail. That is the simplest thing and clearest out. But as to Mr. Slater-Booth or Mr. Rawlinson knowing anything about it, I doubt. It is by mere accident that you know anything about it, the accident being that I saw the thing at Warrington, and I said, "Do send this thing up to the Society of Arts, and show them what is the cheapest and simplest invention that is out for this purpose?" Now, that is the sort of thing that the Local Government Board ought to give us information about. There is inevitable ignorance. They ought to make it the business of its department to bring all these subjects before the public, and to do it periodically—not to do it by a jerk once in three years. A great many people do not know anything about this Blue-book of 1875. The Stationery-office can not afford to advertise it, and it is a mere accident if it happens to get out anywhere. Now, I say that that is the kind of duty which the Local Government Board is able to do. It is not difficult to make it competent. With respect to this question of getting information, I tried and got some information last night. I am told that Lord Stafford moved for a return of the urban authorities having over 5,000 people, to state if they have any water in their districts. Well, we do not see the return named in the papers. The return will be made after a year or two—not before, I think. It has taken three months to get an answer as to whether the return can be made or not, but at last the answer is obtained. Well, there is another return. Why, it was two years in gestation, and I dare say you gentlemen here do not know much about it. It is a return moved for by Lord Rosebery in the House of Lords. I wonder whether the gentlemen who know anything about it will put up their hands. Well, there are three hands held up—three shining lights. Now, this return is a return of every urban sanitary district in England and Wales having more than 5,000 inhabitants, giving the method by which the sewage and excreta are disposed of, and the method by which the sewage is treated before it comes to a stream, the name of the river which it pollutes, a description of the manufactures; the length of time the system has been in operation, and so on. And here is a most interesting return from all the counties of England, and if I were in the habit of making wagers, I would make a wager that not 25 copies of this book has been sold. But this is exactly the work which the Local Government Board ought to do. If they would only produce a work like this, and make it extensively known for the benefit of you gentlemen, they would be almost worth the money they cost. But they have not yet arrived at that stage of action. Well, you know, they certainly have no right to have prejudices, that is quite clear. We do not pay them to stop us in our progress in doing things, and their prejudice does stop us. We will not allow that if we can help it. You know the Society of Arts has got hold of the stick, and will manage to work it so that the Local Government Board shall not stop the sanitary work of the country. Well, now, I have only to say that I am thankful to the Local Government Board even for its very small mercies, but I think they want a hearty shove to give us a good many more. And, amongst other things, I should be delighted if we could nail them to the responsibility of the state of the metropolis; but, however, that is too great a business. You go and say that a drain pipe is out of order, and you cannot get any attention, and you cannot have it even from the Home Secretary. You know that the state of London throughout is excepted from all sanitary authorities. It is a sort of "Arabian Nights" fact that the Metropolitan Board of Works has a monopoly for polluting the Thames. That is the only body in the country that has the prescriptive right to be beastly and prejudiced. Well, then, when you come to look at it, they set up all kinds of men of science who are, no doubt, very profound; and treat the question so microscopically and scientifically that you get into such a fog that you do not know what to do. They get science to prove that this stuff going into the river does no harm at all. No doubt the next thing that they will do will be to prove that it is otto of roses, and I dare say that I shall get so confused on the subject that I shall believe it. But what does the pouring of this filthy sewage into the river mean? That the Board is afraid to pay for a clear effluent that is not stinking, which will only cost from 3d. to 6d. a head per annum of the population.

The Conference than adjourned for half an hour. Upon resuming—

A paper, dealing with the subject "Whether any further Legislation of a compulsory or permissive character is needed for bringing about a better Sanitary Condition of Towns or Dwellings," was read by Mr. Henry Robinson, C.E.

Mr. Lawrence-Hamilton said that he was sure that that love of fair play, which characterised all intelligent

men, would not be absent from them that day. It was therefore with considerable regret that he had heard a series of attacks made upon the Local Government Board, and one of them was associated with the name of a great pioneer in sanitary science—a man who, perhaps, with Mr. Chadwick, had done more for sanitary science than any man in existence. He (Mr. Hamilton) referred to Mr. Rawlinson, whose writings were full of learning and thought; and although Mr. Rawlinson has that day been blamed for being old by an honourable speaker, who was not at that moment present, he (Mr. Hamilton) did not consider that when a man was the leader of a young school of thought, and a young school of action, his being old was anything to his discredit. As regarded the Local Government Board, he (Mr. Hamilton) was certainly not their champion; but by a series of accidents, he was brought very frequently in their way; and he must say, with all due respect to the great luminaries whom he then had the honour of addressing in that room, that they would find at the Local Government Board men whose genius, integrity, experience, ability, and knowledge were quite as great as those of the gentlemen who were then in that room. When they had at the Local Government Board men like Rawlinson, Netten Radcliffe, Buchanan, Ballard, and Seaton, they might be content that such men had been selected by the Government. The unhappy feature in the position of the Local Government Board was that, at every turn and every twist, they were interfered with by no end of powers which acted against them. The Local Government Board had no money to carry out one-twentieth of the things which it desired to effect. The Local Government Board was appointed without sufficient money, and then, having insufficient funds, and insufficient local powers, it was blamed because it did not do an impossibility. Mr. Chadwick had just assisted him (Mr. Hamilton) with some notes from that copious encyclopædia which he carried in his head, and he had reminded him that the government of London, as regarded its sanitation, was in the hands of various offices. There was, first, the Office of Works. The Office of Works, as most of them knew, had all the London palaces under its control. Then there were thirty-six Vestries, each of which put its spoke in the wheel, occasionally, and very frequently, to hinder progression and to accelerate retrogression, which was the normal, the natural, and almost the necessary effect of the Vestries throughout the United Kingdom. There was then the City Commission of Sewers, and the government of the City of London itself. As they were well aware, the City was particularly well managed, and it had powers of its own. There was then the Metropolitan Board of Works, and they had certain powers. Mr. Chadwick had reminded him that in twelve miles of road in London there were nine jurisdictions. Referring to the attacks which had been spat at the Local Government Board, he would appeal to them, and ask how the Local Government Board, hampered, hindered, impeded, and thwarted at every step, could, without full powers, be held responsible, because the Government of the country had not given them that complete power which the Local Government Board ought to have.

The Chairman—I think I had better draw your attention to the fact that, as far as I have understood the remarks previously made, no attack has been made upon the Local Government Board with reference to the sanitary condition of London. It is perfectly understood that the Local Government Board has no supervising power over the London vestries or the Metropolitan Board of Works.

Mr. Lawrence-Hamilton said that he was grateful to the Chairman for calling him back to the subject, but he (Mr. Hamilton) had simply touched upon that because a certain amount of blame had been attached to the Local Government Board, and he wished to show what its real position was, because it might have slipped the attention of certain gentlemen present. With regard to an observation that had been made by an honourable speaker, alluding to the matters of irrigation and filtration, he (the speaker) conceived that the reports of the Local Government Board were very satisfactory and very full. The Local Government Board were of opinion that wherever irrigation and filtration by land could be had, that was the system to adopt. Individually, he followed that same school. They had been further informed that the Local Government Board was not worth the money it cost the country. It was upon that remark which came from a gentleman who was absent that he ventured to rise, and to state that he did not believe that such a wide and sweeping statement was borne out by fact. He had not in his memory the exact figure which the Local Government Board cost, but he knew that for the work which it did, that it was well deserving of the support and the sympathy which it had frequently received. An honourable gentleman had laid great stress upon a stink-tub, or stink-pail, or stink-pot, whichever it might be called, and had shown it to the meeting as a marvel of genius and a marvel of hygiéne. He (Mr. Hamilton) would appeal to them as individuals, and ask, whether they could have a better instrument for the distribution of zymotic or preventible diseases than that stink-rag which flouted round the pail. He was sorry that the gentleman who had referred to it was not there, but he must say that it was carrying the joke a little bit too far to appeal to them, as educated, scientific, or unscientific men, whichever they might be, that it was wise and judicious that such an instrument for circulating disease as that pail, should meet with the support of a Society of men capable of thought, reflection, and intelligence.

Mr. Monson, of Acton, said that he had listened with a great deal of attention to the remarks of Mr. Cresswell, and he wished to make a few observations on local board elections generally. He (Mr. Monson) had just contested an election, and he had found that there was no register of voters. There was the standing order of the Poor-law Board that the collectors should mark those persons who were qualified to vote, and there was a register for the election of guardians, but there was no register for the election of local boards. It was at the will of those persons issuing the voting papers as to whom they should issue them to. In the case of cottagers, the papers would be issued to those persons whom they could control, but those whom they could not control would be left out. He should like to know whether the Municipal Corrupt Practices' Act could be put in force with regard to local board elections. Perhaps it might apply at the present time, but it was not very clear whether it applied or not, and then the consolidated order of the Local Government Board, with regard to the conducting of elections for guardians, should apply with reference to the elections of local boards. In the recent election in which he had been concerned, the returning officer was a farmer, and he did not understand what was correct and what was not; whereas, if there had been a poor-law election, the returning officer would have been the clerk, a lawyer, who understood the Act, and the election would have been properly conducted. If the committee were going into the question of elections, he should be very happy to send them up several cases which had come under his notice in connection with such elections.

Mr. Alcock said that there were two points to which he should like to call the attention of the Conference, and which, in his opinion, required further legislation in connection with the Public Health Acts. Of course, in speaking upon this question, which was a very large one, each gentleman would, probably, give the effect of his own experience of the working of the Acts in his own district. There were two points which had struck people in the neighbourhood of Sunderland as points

upon which it was desirable to have further legislation. One had been already mentioned by the Chairman—the question of bye-laws relating to buildings. Most large towns had taken the opportunity, when they had found it necessary, to go to Parliament to obtain statutory enactment for their building regulations. No doubt they had found, as had been found in Sunderland, that bye-laws were to a certain extent unsatisfactory. There were very many questions raised in connection with the validity of bye-laws. There were very many questions connected with the expediency of bye-laws which were submitted to the Local Government Board, and upon the whole bye-laws were not found generally, to be the most satisfactory method of legislation in connection with sanitary matters. The metropolis had been referred to with reference to the subject of sewers. The metropolis had also a Building Act, and it was the opinion of gentlemen in Sunderland that there was no reason why there should not be a General Building Act which might be applicable to the whole of the country. It would be impossible, of course, to say that the whole of the building regulations should apply to every part of the country, including small rural districts. But the people of Sunderland thought that it would be quite competent to give to the Local Government Board a discretion as to applying portions of such a Building Act to urban authorities and to rural authorities, as they might from time to time consider desirable. For instance, what was a rural authority to-day, might in ten years' time become an urban authority, and, therefore, the building regulations that might be applicable to-day to a small rural village would require to be enlarged. This necessity would be entirely met if the suggestion which he wished to make to the Conference, was carried out, namely, that there was a general Building Act, and that certain portions of it might be applied to all districts, including rural and urban. Then, as a district came to have more of an urban character, the Local Government Board might have power to apply all the provisions to it, including those which applied more to an urban than to a rural district. As a rule, he had no complaint to make against the Local Government Board, except delay. He believed that they were as anxious to carry out their duties of a central character as local authorities were to carry out their local functions in their own districts; but in the operations of the Local Government Board bye-laws there was delay, especially in reference to building. They had had such an amount of work thrown upon them by the Act of 1872, and the Act of 1875, that they had hardly been able to cope with it. It took two years to get one set of building laws, in connection with a rural district near Sunderland, approved by the Local Government Board. Those rules were made applicable for six of their townships, but one township was omitted, as it was not then thought that it would be built upon. They very readily got the urban powers, for, in fact, the Local Government Board had shown a very great disposition, indeed, to give local authorities urban powers wherever they could show any reason for putting them in operation in their district. Shortly afterwards, the same powers were required for the township which had been omitted when the powers were sought for the other six townships, and the local authority thought they would have nothing to do but to submit the same regulations for approval with reference to the one remaining township, and would then be able to get them approved immediately. To their amazement, they found that such was not the case. They had to begin the whole question over again, and it took them 18 months to get a set of bye-laws for the remaining township. That was not the worst of it. When they had got the set of bye-laws for the remaining township agreed upon, after 18 months' discussion, tho local authority suggested that they might apply the same bye-laws in the other six townships, so as to have one uniform set of regulations for their entire district. They thought, "Now, certainly, we shall be able to get this agreed to without any difficulty;" but, to their amazement, they were told by the Local Government Board, that if they submitted a new set of bye-laws, applying to the whole district, they would be opening entirely the reconsideration from beginning to end. The local authority, were, therefore, under the necessity of declining to reopen the question, and of continuing with two different sets of bye-laws. There was no power given to a sanitary authority over the size of rooms. In Sunderland, they frequently had plans sent in showing bedrooms of very infinitesimal size; indeed, barely sufficient to hold a bedstead; and if they suggested any alteration they were met at once with the objection, that they had no power over the matter. With reference to the height of rooms, the Local Government Board had told the local authority that there were very considerable doubts whether they had any power over that point. He thought that it would be conceded that both the size of rooms and the height of rooms were very material elements in reference to the question of health. Now, they were submitting a series of bye-laws, and they provided in one of them that the yard or open space at the back of a house should have a certain fall from the house. In Sunderland they had a street on both sides of the houses, what was called a front street for the front doors of the houses, and also a back street for the back doors of the houses. They provided that from the house to the back street, or to the yard wall, if there was not a back street, there should be a certain difference of level —a falling away from the house—in order to secure drainage. The Local Government Board proposed to strike out the bye-law providing for that, and said that there was no power whatever to make a bye-law with reference to the level of the yards, or open spaces behind the dwellings. The local authority maintained that there was a power, because it was absolutely essential in respect to the drainage that there should be a fall from the house, and therefore they were to have an interview in the course of a few days, and they hoped to convince the Local Government Board that the requirement for the difference of level was within their powers, though at present they objected to it. Another thing which the Local Government Board objected to, somewhat to the surprise of the Sunderland authority, was a regulation with regard to the hearth-stones. The local authority provided that the hearth-stones should be embedded with a certain incombustible material, and they had received a reply which stated that hearth-stones were not within the Act. Another very important question, which had arisen in their district in reference to the building bye-laws, was connected with the making of streets or roads. A person would send in a plan showing streets with proper levels and everything else in order, and he would get it passed; but having got it passed, perhaps he failed to proceed to form the street, but sent in a plan for an individual house, or for a few separate houses, to be built in different parts of the street before he made the roadway. The consequence was, that it was very difficult to get the house built in such a way as to conform to the proposed level of the street, and it was very difficult indeed to get the street made within any reasonable time of the houses being built. He thought that there ought to be some power given to sanitary authorities, to say that, before a man began to build houses, or certainly before he began to build any number of houses in a certain street, he should form the street. He believed that in most districts in connection with the metropolis the streets were formed, levelled, and kerbed, even if not paved, before the houses were built; but that certainly was not so in the north of England, as far as he was able to ascertain, and the local authority did not seem to have the power to compel it. At Sunderland they proposed to put in a bye-law, saying,

that before a person began to build houses he should make a rough formation of the road, and put in a kerbed footpath, so as to show the level of the proposed street, but they were met by the Local Government Board with the remark that that was not within the powers of the Act of Parliament. Under these circumstances he thought—and he hoped that most of the gentlemen present would agree with him—that it would be very desirable to have a Building Act applicable to the whole country, with power to the Local Government Board to apply such provisions as they might consider desirable to the rural districts, and such as they might think desirable to the urban districts. There was only one other point to which he would call attention. There were others which he could name, but this was a point which he considered of very considerable importance, and that was the question of notice of infectious disease. At present the medical officer of health had no means of ascertaining where the cases of infectious disease arose within his district. There might be scores or even hundreds of cases where attacks of infectious disease had manifested themselves, and yet the medical officer of health for the district might be in entire ignorance of the fact. He did not think that any one would differ from the statement that it was very desirable that the medical officer of health should know at once of any case of infectious disease. He had no means of isolating the case, and preventing the spread of the disease, unless he was made aware of the fact of its existence. He (Mr. Alcock) thought that some person—probably the landlord's tenant, as it had been said in some of the papers that had been already presented on the subject, that is to say, the principal tenant of the house—should be compelled to give notice to the medical officer of health of the existence of infectious disease the moment it came to his knowledge. Some gentleman might say that it was desirable to impose that duty also on the medical attendant; but he (Mr. Alcock) was afraid that that proposal might lead to considerable opposition amongst the doctors, and therefore he was rather afraid to propose that. He would be content if the person virtually in charge of the house should be compelled to give notice of the existence of infectious disease as soon as its occurrence came to his knowledge, in order that the medical officer of health might take the necessary steps for isolating the case and preventing the spread of the disease. He might state that the practice pursued, with reference to schools, had been very objectionable in his locality. That was an item which must have come within the knowledge of a great number of medical officers of health lately, especially since the Education Act had been put into operation. The officers of School Boards found themselves in considerable difficulty in enforcing the attendance at schools on account of the existence of infectious diseases. The parents sometimes made the excuse that a child was ill. That was an excuse easily made, and if School Boards listened to it constantly, the schools would be neglected, notwithstanding that there might be no ground for the absence of the children. On the other hand, there were a great many cases of infectious disease, such as measles, which the mothers were able to attend to without the aid of a doctor, and in many cases the parents were too poor to call in a doctor. During the last week they had a case before the district committee of the Board of Guardians at Sunderland. When parents came in for relief in the ordinary way, they were generally asked the question, "Where are your children at school." Then they gave the name of the school, and the guardians turned to the books, which they had before them, to see what had been the attendance of the children. It was now compulsory upon guardians, before granting out-door relief, to see that children were in attendance at school. In the case which he had just referred to there were two children, one not in attendance, and one who had made ten attendances during the week, which was the full number. The committee asked the cause of the absence of one of the children, and they found that that child was suffering from measles whilst the other was in constant regular attendance at school. This was a very dangerous matter because, no doubt, there was a great risk of an infectious disease being spread through the entire locality and neighbourhood in this way; and, therefore, he thought that this was a question which called for legislation with a view to prevent the evils arising, both in connection with health and, virtually, in connection with education. He, therefore, trusted that it might be found possible to have more legislation upon that point, throwing the duty of informing the sanitary authority either upon the tenant of the house or upon some other person. He should be glad to hear the views of the Conference upon the matter.

Dr. Child said that he thought that the best, because the most general argument for further legislation upon these matters consisted in the fact, which he believed every one of them there would admit, that the legislation which they had at present had completely failed to produce the results for which it was intended. When he said that it had completely failed, he spoke advisedly, because he took it that no one would suppose that what might be called the mere removal of temporary nuisances was the object, or, at any rate, the sole object of the sanitary law, or that, if it were so, such object would justify the elaborate organisation and the enormous expense which was now spread over the country for sanitary purposes; but yet it seemed as to him that that was only matter in which they had been successful. He thought that it was impossible to doubt this, because the evidence to be derived from the reports of medical officers and others, really existed in such quantity, and they had had such a lot of it quoted that day, that it was really not worth while to take up the time of the Conference in repeating it. The evidence that they had got proved most conclusively that, so far as water supply, drainage, house accommodation, and the prevention of epidemic diseases were concerned, very many defects remained in all those particulars, and those defects, in many parts of the country, were scarcely less appreciable now than they were before the passing of the Act of 1872. He supposed that every gentleman present could point to villages and towns—and more particularly he might add, the growing suburbs of existing towns—in which all the old abominations of cesspools close to wells, and things of that kind were not only still existing, but increasing, and multiplying, and increasing, and multiplying at least, in as great a ratio as the increase of the population. If they looked into that question in connection with the increase of population, he thought that they would find that in the country districts and suburbs there had been no advance at all; all that they had succeeded in doing—even if they had done that—was to retain the *status quo* in which they were before the Act of 1872. He had always admitted that the passing of that Act of 1872 was the greatest advance which was ever made in this country in sanitary legislation, and he thought that the right honourable gentleman in the chair, whose name was connected with that advance, would be the last person to tell them that the Act of 1872 was ever intended to represent finality in the matter. He (Dr. Child) had ample reason to know and to say that the Act of 1875 had been, in a great measure, a delusion, and, considering the way in which it had been worked, he might almost say that it had been an imposition on the public. Let him put himself right about that matter. He would say that the Act of 1875 had been a benefit in one respect. Of course it had been an enormous benefit to their legal friends, who now really did know where to find the sanitary law, but he believed up to that time they found it exceedingly difficult. But he believed that that was not only the greatest, but the only real benefit, which that Act had produced. Nay, he would go farther, and would say

that that Act had tended to hinder sanitary progress, because the Local Government Board adopted that Act as a matter of finality, and they were always telling the public that they must be thankful for what they had got. The defects in the present law were of two totally different kinds, but, as time was pressing, he would refer to only one of them. There were defects which had been referred to again and again, and which the present Public Health Act Amendment Bill proposed to remedy in regard to one division of sanitary matters, namely, water supply. These were defects in the machinery of the Acts as they stood, and which were capable of being remedied by altering the Acts; but there were other defects of a more serious kind which affected the whole system and spirit of the sanitary laws at the present moment. Those defects were, first, the permissive principle, and, secondly, a double government in the way in which it was now carried out. With regard to the permissive principle, he could not for his life see what was the use of permitting certain persons to do certain things which they had a vast preponderance of motives to leave alone, and that was very much what was the case at the present moment. The law permitted a Board of Guardians consisting, he would say, of A, B, and C, to take certain steps on their own responsibility, and at their own cost in the way of trouble and care, and very much at the cost of themselves or of their immediate neighbours in the matter of expense, and these steps were to be taken for the benefit of D, E, and F, who were persons who contributed little or nothing towards the expense, for, after all, the question of sanitary improvement was mainly a question of the poor. The men who sat at the Board of Guardians could generally manage to have decent water to drink themselves, provided that they had sense enough to care to obtain it, and they did not care so much about their neighbours. That was a matter of human nature. They all knew that they looked out for number one first in a vast number of things, and in all commercial matters it was generally looked upon as a proper principle to do so, and the principle was acted upon accordingly. If they passed a law by which they permitted certain persons to do a thing it seemed to him that the very use of the word "permit" implied that they also permitted them to leave it alone. The two words, permission and duty, which, by-the-bye, were used almost in very same sections of some of the sanitary Acts, seemed to have no relation to one another. If a man might do a thing if he liked, it could hardly be, in any legal sense of the word, his duty to do that which he was only permitted and not compelled to do. It seemed to him, further, that the framers of the Act really saw this distinction, and it would have been odd if they had not seen it. He believed that the framers of the Act really did see the distinction perfectly well, and that that was the meaning of Part IX. of the Act as it now stood. Then, as to the second part of the question, it was the fact that, not only had difficulties arisen from the permissive principle, but they had also arisen from double government, which practically divided the responsibility so completely, that neither of the two parties concerned felt any real responsibility in the matter. The local body, as he had said, without entering into the question of proponderance at all, had a great many motives to induce it to leave matters alone, and the mere fact of feeling that there was a further body which could be applied to when the local authority failed, removed the sense of responsibility to a great extent; and when the local authority knew that that other body, if applied to, would be likely to leave the matter alone, that knowledge acted as a still further inducement to inaction on the part of the local authority. Then the Local Government Board had adopted the consistent policy of leaving everything to the local bodies that could be left to them. The constant reply to all appeals to them was, that they could not undertake to do the duty which really belonged to the local body, and so, between the two stools, sanitary improvement came to the ground. He could not agree with the gentlemen who had defended the Local Government Board, because if the clauses 299 and 293 were taken in connection, and really worked as their wording would indicate, the Local Government Board had ample power to compel every local body to do a vast number of things which at the present moment were not done. They all knew that a complaint being made under the Act was interpreted to mean a complaint, not by some officer of a local body, but by some person *ab extra*, and the Local Government Board would not act without such complaint. This amounted, in a vast number of cases, and especially where poor persons were concerned, to practically declining to do the work at all. He could not believe that the words of clause 299 alone necessarily implied that result, and he was quite certain that if that clause was read together with the 293rd clause it could not intend such a result. The words of the 293rd clause were these:—"The Local Government Board may cause to be made such inquiries as they see fit in relation to any matter concerning the public health in any place." Could they imagine words much wider than those of that clause? And when they remembered that the Local Government Board had a number of salaried officers of its own who acted as inspectors, and whom it might employ for any purpose and in any place whatsoever, how it was possible to shirk the responsiblity which those two sections brought upon the Local Government Board, passed his understanding. The Local Government Board seemed to him to have carried the policy of "how not to do it" to a degree of perfection that was not to be found in any part of the world outside Turkey. He would only just say one word in conclusion, and that was in reference to something which fell from Mr. Cresswell with regard to the remedy which he proposed, namely, county government boards. If by introducing county government boards Mr. Cresswell meant to introduce them as proposed in the Bill now before Parliament, he (Dr. Child) should have great doubt of the advantage of them, the reason being that the Bill tended to multiply jurisdictions in country districts which were already most frightfully multiplied. They had at present, in the way of jurisdictions, petty sessional divisions, then Poor-law unions which were also sanitary districts, and then small local boards which were sanitary districts within the districts of Boards of Guardians; they had also highway boards, and parish committees. He must remind them that these authorities were constantly conflicting. Then there were unions which extended into different counties, and such practically had to work several different laws, because the sanitary law was worked through the clerks of the magistrates, and in one place, it would be interpreted by one lawyer, and in another place by another lawyer. Then there was sometimes a small urban district within the union, which for sanitary purposes had a district of its own. Suppose that in such a case there was an outbreak of small-pox. It would be found that the Vaccination Act was worked by the Board of Guardians, as a Board of Guardians, through their own medical officer and their union authority. All other infectious diseases were put under the control of the sanitary authority as a sanitary authority, and of the medical officer of health, as their officer for that purpose. These two different authorities might have, and frequently did have, two different areas of jurisdiction, and different officers who did not always pull together, as it might be wished they should do. That was a very strong point. Then there was one other point, with regard to the question of county government boards. He should like to see his way a little more clearly in regard to them in connection with the difference between the rich and the poor. In using the terms, "rich" and "poor," it is very difficult to avoid being misunderstood; but for practical purposes, when people spoke of the poor, they meant the very poor—the actual day-labouring class, and no one else—because

the small tradesman, or small lawyer, or any other individual of that class, was quite as much a rich man for practical purposes as the millionaire or the landowner. In fact, in some cases, he was more so, for they all knew instances in which, though the territorial aristocrat was a very great man indeed, yet his agent was a much greater man. He should like to see some device by which the interests of the poor in this matter would be protected, and if he was confident that the vote by ballot would protect them he should support it. He was not so clear on that point, and he could not help thinking that this was a matter which went a little beyond rural and local considerations, and affected the Local Government Board itself. The president of the Local Government Board was generally a Member of Parliament, and very often a county member. And in counties, at all events, the nuisance mongers had votes, and the sufferers from nuisances had none. He could not help thinking that that fact went far to account for the Local Government Board having done nothing.

Dr. Montgomery McCurrey said that it might be left to every reasonable man to bear out the assertions which had dropped from Mr. Cresswell that day. He felt it his duty to mention a case of which he was perfectly cognizant, and which affected the medical officer of health in a large district, for he believed that the case was one in connection with which good results would accrue from the introduction of the ballot. A medical officer of health in a large district lost his appointment simply because he did his duty, and gave offence on a military question to a gentleman who possessed and held a large amount of property in the part of the country where the officer was engaged. He had a number of the militia placed under canvas instead of being billeted on the property of the landed proprietor. There were only seventy-four billets to be obtained for a thousand men, and none of the billets could accommodate more than nine men, and some of them could accommodate only seven. The medical officer represented to the Local Government Board, and he represented to the Horse Guards, feasible and proper grounds why the thousand militia men should not be billeted in the town, and he requested that a medical officer might be sent down, either from the Horse Guards or from the Local Government Board in London, to inquire into the validity of his representations prior to any steps being taken. Two of the representations which the local medical officer made were that small-pox was prevalent within a few miles of the town where a number of the militia men were coming from, and that there was not sufficient accommodation for the men. This officer was a gentleman who had been 13 years a public servant in all parts of the world, but in consequence of his action in this matter he was dismissed from his appointment. He (Dr. Montgomery McCurrey) mentioned this case in order to bring before the Conference how guarded medical officers were obliged to be in carrying out their duty.

The Rev. W. Freeman asked for the attention of the Conference to a few words on the question of imperial legislation, as affecting small country districts. He could not do better than refer to two or three facts, and leave them to speak for themselves, rather than to occupy time in any other way. He came from Norfolk, and had the honour to represent the local board of a town in that county. Some time ago, the town was under the government of a rural sanitary authority, which consisted of the representatives of 64 parishes in the union. That authority determined upon a scheme for the drainage of the town in which he (Mr. Freeman) lived. The gentlemen who composed that rural sanitary authority, coming as they did from agricultural districts, were nearly all of them farmers, and had little or no interest in the township. An engineer was sent for, who prepared, at an expense of more than £700, elaborate plans of drainage and water supply, for a small town of 5,000 inhabitants. The scheme would ultimately have cost £30,000. It was a very beautiful scheme prepared by an eminent engineer whom he (Mr. Freeman) had had the pleasure of seeing in that room during the last four days; and the people of the town thought that it would be a very good scheme for a place like Birmingham, but that it was not adapted for so small a town, and it would certainly put upon them an intolerable burden. Some of them also had an objection to sewage irrigation, and the more so because it involved the necessity of having water as a carrier of sewage, and they had no water in the district. They were dependent for water entirely upon the wells which had been dug for each house in the town, and they would have been under the necessity of boring and expending a large sum of money in order to get water, not only to satisfy the natural and necessary requirements of the people in town, but to supply 100,000 gallons daily as a carrier for the sewage. They had a further objection to sewage irrigation. The townspeople, therefore, set themselves vigorously to oppose the scheme, and the result was the formation of a local board; but they found that the Local Government Board was so thoroughly committed to the plan of water-carried sewage and irrigation that the representatives of that Board, who, in all other matters, treated the local board with the greatest possible courtesy, treated them in this respect as they were told they deserved to be treated. They were told by Major Tulloch, only in March last, that they were among the bad boys of the country. The sanitary authorities and the local boards of the country were classed by the Local Government Board under two heads —good boys and bad boys. The good boys were those who adopted the scheme of drainage and sewage irrigation, which had been sanctioned by the Local Government Board; and the bad boys throughout the country were those authorities which had chosen to think for themselves, and who believed that sewage irrigation was not the only or even the best mode of disposing of sewage. Major Tulloch went further, and when he came on an inquiry as to improvement of the market-place, he said, "Gentlemen, you must not expect the Local Government Board to assist you in any of your schemes for local improvements, so long as you refuse to assist the Local Government Board by carrying out their scheme of drainage."

Mr. Lawrence Hamilton—Quite right.

Mr. Freeman said that this touched directly on the question which was before the present assembly, namely, the question as to how far imperial legislation and administration affected the action of local authorities with regard to sanitary improvements. He thought that such an assembly as that ought to clearly understand whether the Local Government Board would assist local authorities in country districts and small townships which were not able, like Birmingham, to make their voice heard throughout the country. If the Local Government Board had set themselves to oppose any improvement, whatever it might be, suggested by the local authorities, unless the local authorities would submit to be handed over to the eminent civil engineers of this country, to be dealt with by them after the fashion in which they certainly would be dealt with, and which was not always to the interest of the people, but generally to the interest of the civil engineer himself—if the Local Government Board determined to oppose any improvements in small towns until the small towns would submit to such a rule as that—the sooner local authorities understood it the better, and the sooner the Legislature of the country understood that this was the course taken by the central administrative authority appointed by them, the better for the people of this country. While large cities, such as London and Manchester, and towns like Birmingham, could always stand up and speak for themselves, and make their voice heard, the greater number of the

towns throughout the country were in the position of being tied and bound, hand and foot, by the Local Government Board in these matters of sanitary improvement. There were to be found in small towns men of intelligence, who knew what was right to do, and who had exercised their judgment in trying how to find out how to do it. And when local residents, who had given their time and attention for years to sanitary matters, found themselves fettered, their whole nature was stirred within them when they saw that sanitary and social improvements were impeded, and sadly impeded, by the red-tapeism of the Local Government Board of England.

Mr. Baldwin Latham said that he happened to be the "eminent engineer" that was called in by the rural sanitary authority referred to by the last speaker. The fact of the matter was, that he did not believe that there was a more conscientious or competent body of men than the rural sanitary authority of that district, and to say that those gentlemen had no interest whatever in the town of East Deerham was quite beyond the mark. Some of them were located in the immediate neighbourhood, and had property within the precincts of the town, and were just as much interested in the welfare of the town as any member of a little local board could be who set up for self-government. It had been said that the works for the disposal of the sewage of that place were going to cost £30,000. He (Mr. Baldwin Latham) would say that it was perfectly untrue, and that no such sum had ever been asked or been sanctioned by the Local Government Board. Just half that amount had been sanctioned by the Local Government Board for the complete works for the drainage, sewage disposal, and water supply of the district, which estimate included all expenses connected with the works; and for a person to come to that meeting, and make the meeting believe that £30,000 was going to be spent simply upon a sewage irrigation scheme, was by no means justifiable. The sanitary history of that particular town was one which showed that there needed to be an amendment of the law, in order that the poor of the district might be protected against themselves. In this little town of East Deerham, a large plot of land was lying in a beautiful situation, which could be commanded for the sewage of the town by gravitation, but it belonged to certain poor people, who had a right to turn out cattle upon it. In looking at that district, it appeared to him (Mr. Baldwin Latham) that it would be for the welfare of the people if he put the sewage of the town upon that piece of land in order to improve its value, and hand it back to them in its improved form, after the money expended and the sewage had been put upon it, so that the people, who had the right of user, would reap the advantage of any improvement, for at present the land was a miserable swamp and bog. But what happened? Why, the piece of land was guarded night and day, month after month, in order that the engineers should not survey it. Those who guarded it little thought that the engineers could survey the land all round, and so get a correct plan of that particular spot in spite of the guard. Then the people who guarded it thought that the engineers would never be so irreligious as to go and take levels on a Sunday, and so they neglected to watch the land on Sunday, and the engineers were able to complete their sections of the work. That only showed the enormous amount of opposition which was met with in the lower strata of society in that particular town to sanitary improvement. It further showed the difficulties which sanitary authorities who were intent upon doing their duty had to contend with. He could tell them distinctly that the local board of East Dereham had been got up simply for the purpose of scotching sanitary process and sanitary works. It only showed how great a necessity existed for control. The Local Government Board was extremely lenient with towns which were intent and earnest in doing sanitary work, and allowed them all the latitude which was possible. And even in this case they had said to the town in question, we will give you an opportunity of carrying out any sanitary improvements you like, but mind you must do it; you are not formed for the purpose of obstruction. But obstruction was really the object for which this local board had been formed. Then, with regard to the remuneration of the engineer, which had been referred to, he (Mr. Baldwin Latham) might say that up to the present time his account had never been settled. This was exactly the difficulty that he was in. An order had been made by the Local Government Board, and the rural sanitary authority had handed over all the money and plans to the urban sanitary authority. But the urban sanitary authority said, "The rural authority had no right whatever to incur this responsibility. We did not engage you, and we leave you to get your money the best way you can."

Mr. Freeman asked to be allowed to say a word or two in explanation. Mr. Latham had told them that up to that time he had not been paid his charges for survey and plans. But the fact was, that he had been paid over £700 for his scheme of drainage of the town of East Deveham. The amount which was not paid was £127, which he had further charged for having, without authority to do so, engaged Professor Ansted to make a geological survey of the district It was not fair to make a statement of the kind which Mr. Latham had put before that assembly, as to his having not been paid. What remained unpaid was a disputed account. It was equally untrue that the local board of the town were now impeding sanitary improvements. They were devoting themselves most earnestly to sanitary improvements, and the statement which had been made in that respect should be estimated with Mr. Latham's previous assertion as to his charges.

A paper on "The Necessity for Legislation empowering Urban Sanitary Authorities to prevent the proprietors of houses, erected before the constitution of Local Boards, from building upon the whole of the open space belonging to such houses," was read by H. J. Yeld, M.D., F.C.S., Medical Officer of Health, Sunderland.

Dr. Syson said they were all agreed that there was some further legislation required, but he thought that they had hardly considered whether enough had been done with the legislation which they had already had. He thought it would not be hard to bring out from the experience of the gentlemen present plenty of facts to prove that the Local Government Board itself was hardly as well organised as it might be, or marshalled its forces as well as it might do. With its present powers a great deal more might be done. Then there was the muddling up of different kinds of work. He had the greatest respect for the officers of the Local Government Board personally, but he had no respect for the system under which they worked. They muddled up Poor-law work with public health work, instead of having different departments for the Poor-law work, and the medical work. There ought to be a separate department for medical work with a proper balance of medical advisers, legal advisers, chemical advisers, and so on. He would recommend—to put it straight—that there should be a Minister of Health. The Poor-law people were already overcrowded with work. Then, again, the country was spending a great deal of money over sanitary work with confessedly very little effect and they were frittering their money away. In a district properly mapped out and apportioned, one man could do the work which three or four were now doing. For instance the office of inspector and medical officer of health might be combined with that of the vaccination inspector. Of course there was not time at that meeting to go into details, but those who were behind the scenes knew that three men were being employed to do the work of one. Then, again, those who were on the medical staff felt that they

were, to a certain extent, at the mercy of the Local Government Board inspectors, who might be wise men or who might be unwise. Where there was a wise inspector things would go well, but where there was an unwise inspector both Poor-law and other things would go on very badly. Then, further, some persons expected too much from the Local Government Board. They would never get a Local Government Board who would say to a town when it was in a difficulty, "Oh, here are the plans, and this the way out of it;" but on the other hand, he thought that the Local Government Board should be a little kinder mother to certain authorities than she was at present, and should do something to assist them. It would never do for the local boards to be architects and engineers. On the other hand, they ought to avoid a dictatorial tone, and give friendly assistance wherever they could, and lead and teach. It was universally admitted at that Conference that, if a local board sought advice from the Local Government Board, the latter generally declined to give it, and when it was given it was not given in the plainest and clearest language possible. For his own part, he thought that the legislation which was required was very simple indeed. He was rather in favour of permissive legislation, for he thought that they must learn to walk before they ran, and he certainly thought that they ought to put their shoulders to the wheel, and ask gentlemen occupying the position of the worthy chairman to help them in pushing, and they ought to see whether the first step, after all, was not a thorough organisation at Whitehall. If they re-organised Whitehall, the work at such Conferences as the present would be much more simply and much better done, and the public would get their money's worth for the money which they spent on sanitary administration.

Mr. Edwin Chadwick—We heard yesterday strong denunciations of the defective working of the Local Government Board, and declarations that it "stank in the nostrils" of the local administrations from one end of the country to the other, and these declarations were loudly cheered in the Congress. To-day we have just heard the declaration made that there is hardly a worse piece of administration "outside of Turkey," and particular instances of defective administration, adduced by the learned gentleman who has moved resolutions, and supported by Sir Henry Cole. Now, charges of such a character ought not to be made by gentlemen of such position, and by members of this Congress, unless they are prepared publicly to support them. A competent inquiry into the grounds of complaint may, I conceive, be made the means of important amendment. It is fair to expect that a department charged with large, new, and extraordinary functions may have defects in its working that may well call for revision of a friendly character. One loud complaint that has been made is as to the delay and the unsatisfactory quality of its correspondence with the local authorities. Now, knowing as I do the chief officers there, I am very confident that they will be found to be as hard working men as any that are to be found in any department of the Government. It may, and probably will, turn out that the default is not with them, but arises from the want of a due allowance of force for the work by the Treasury, where there is a great aptitude for economising the means of economy. Of the functions of a central Board to which the right hon. the chairman has adverted, he has omitted one fundamental one, which is this, that it is to be regarded as an agency for the collection and communication to each local authority, for its service and guidance, the principles deduced from the experience of all other places from which information may be obtained. Its enunciations should be, not the mere off-hand rescripts of any one officer, but the well observed experience of all officers within the entire administrative area; and the wider the area of the observation the more complete and valuable are the results obtainable for the guidance of particular administrations. Had the proper exercise of this function which was once commenced, been continued and duly advanced, as it should have been, with extending experience, I can undertake to show that the greater part, indeed, all the material questions, raised at this Congress would not have existed;—the mere gropings in the dark of inexperience, and the confined views of narrow administrative areas and expensive quackeries, would have been prevented. I may give instances of large defaults in this respect, and in the duty of a central authority, as an independent and impartial authority, to see for the protection of ratepayers, and of absentees, that outlays for charges distributed over periods of time, are of a nature to endure, and to be of benefit to absentees, and to reimbursement in the future—equivalent to the charges imposed upon them. It may be that this default is due also to the want of force; or it may be due with other defaults to the want of method, which is to be amended on revision; but I entertain a confident opinion, that from the highest to the lowest of the department, it will not be found to be for want of industry. On the part of local authorities, there are also large complaints alleged in respect to the other great branch of administration with which the department is charged, namely, the regulation of the relief of the destitute. In the early course of the administration of that branch, a Parliamentary inquiry into the complaints preferred against the conduct of the Board was granted, with the result of vindicating and strengthening the central authority. Subsequently, there was an inquiry by a committee, which ended in the condemnation of the Board, inasmuch, as their decisions were not in accordance with the law which they were bound to administer. Instead of a change of persons, and the appointment of others more competent, unfortunately, the change was made of functions by the abrogation of the real Board, and the substitution for the responsible undivided attention of specialists, the rule of the divided and distracted attentions of changing party political chiefs of no special aptitudes whatsoever. The consequences of this in the deterioration of the adminstration of that other branches of administration (which are not now in question at this Congress), have been large and disastrous. Under the amended law, as first fairly administered, the effect was to consolidate and greatly to improve the local administration, with an agency of paid local officers, and to reduce the burthens of the local ratepayers by one half the amount they had previously been. Altered consequences have been brought about, under successive administrations of men, some of them of distinguished ability, but of no special aptitude for the purpose required. The principles of amendment, originally promoted under the Poor-law Amendment Act and demonstrated, in early though imperfect action of partially informed Commissioners, have been amply vindicated recently by petitions from the Chambers of Agriculture, and also from the Boards of Guardians throughout the country, who pray that a return should be made to those same principles of the law as laid down in 1834. But to do this, return must be made to the principles of responsible executive action on undivided attention then provided. In that branch of administration the existing conditions can only be maintained at continued exeessive cost of between two and three millions annually. Efficiency of administration, as a rule, is as the undivided competent attention ensured to it. But the existing official conditions, of the results of which we have here heard complaints, will be found to be such as must frustrate the application of the greatest experience and special aptitude. To that I may testify. I may accept the compliments paid to me in this Congress, as having the most full knowledge of the subject matters of administration in question, derived from prolonged attention to wide fields of observation; and this I can say that if I were a member of Parliament, and if I had to be also a member of the Government, and the high honour of being a cabinet minister, and had thence

to attend cabinet councils, and committees, on other difficult and disparate subjects by day, and the discussions on party and other questions in Parliament by night, the application of the best special aptitudes I may have, would perforce be frustrated, and I must inevitably leave the most important work to the desperate efforts of a secretary, who again must leave it to clerks, where it is notorious it now is and must be; —with clerks who are frequently ill requited for such duties as they have to perform. And if this be so, with the one branch of the administration (which is not here under consideration), what may be expected with heaped up functions, such as have been here in question? I entertain a confident opinion that the defaults complained of will be found, as I have stated, to he not with the persons collectively, but from the default of the executive principles of arrangement, which call for examination. Administrative machinery, like other machinery, should have periodic friendly revisions. The local outscreams against centralisation, I have generally found to be the outscream of jobbers, whom its action frustrates. I do not say that it is so here in any degree. A declaratory resolution should, however, follow the strong declarations made, and I offer one, as an amendment to the string of resolutions proposed:—"That the Congress is of opinion that there are large defaults in the action of the central authority which ought to be the subject of Parliamentary inquiry." I expect greater readiness in the complaints of defaults than of preparation on the parts of those who make them, at present at least, to support them by proposals of remedies. We shall see how this may be here.

Dr. Vacher said that he should like to say a word in support of what had been said by his friend, Dr. Syson, and also with reference to what had been said by Dr. Child, as to the great disadvantage of having to deal with clashing authorities. He considered himself competent to speak, inasmuch as he lived in a district where there were not two authorities, but three. They had the ordinary sanitary authority, and they had the parish authority, and they had the port sanitary authority, and, under these circumstances, when a vessel bringing a patient with small-pox happened to put into their docks, and the patient, or those who were responsible for him, were unwilling to pay maintenance charges, it was really difficult to find out to what authority he belonged. In the first instance the relieving officer was generally applied to, and the answer of the relieving officer was, "Oh, we managed these things very nicely some time since, but now a new authority has been created, and you, as representing them, had better manage the best way you can." In a case of this kind they used to put the man in the workhouse wards, hut now the workhouse authorities said, "We do not feel disposed to have anyone not in the position of a pauper." And then the appeal was made to the port sanitary authority of Birkenhead, which happened to have its office in Liverpool, and it was very difficult to find out who was the proper officer to apply to. The answer from the port sanitary authority was, "Make whatever provision you think necessary, and then send in your bills to this office, and if we do not think them excessive, we will countersign them." And so when a case of infectious disease came into port, the officers did not know how to deal with it, and sometimes the patient was left on board ship for twenty-four hours or more. In other cases, those in which the patients were derived not from the port, but from the town, it was difficult to know to which authority they belonged. The sanitary authority of the town to which he referred had provided a hospital for infectious cases, and they were perfectly willing to provide accommodation gratis, but they felt that if they did that the guardians would cease to receive even pauper cases, and leave the sanitary authority to provide for them. Therefore, it was necessary to put a sort of protective fee upon the hospital, and nobody was permitted to be taken into the hospital whose friends would not agree to pay maintenance charges to the extent of 14s. a week. It occasionally happened that the patient or his friends were unable to pay 14s. a week maintenance charges. For instance, some time since small-pox broke out in the house of a shoemaker, and three of his children in succession were seized with the disease. He was earning only 35s. a week, and, therefore, he was not in the position of a pauper, but the three children could not be provided for, because the relieving officer said that he would have nothing to do with them, and the sanitary authority had no provision for cases for which 14s. a week could not be paid for maintenance. Thus, in these cases it very often happened that the clashing of authorities prevented patients from being properly housed and accommodated, although there were hospitals in the district professing to accommodate such patients.

Mr. Marshall said that he had waited patiently in order that some gentleman of the medical profession might refer to one point which, it seemed to him, had not been sufficiently considered that day. He could not say that it had not been noticed, for it was mentioned by one medical gentleman who had addressed them that afternoon. It was as to the giving notice of the existance of infectious disease to the medical officer of health. That medical gentleman suggested that the occupant of the house should be bound to give notice. But how was the occupier of the house to know what was an infectious disease and what was not? Their object was that the earliest possible notice should be given to the medical officer of health of the outbreak of a contagious disease, and the experienced eye of that officer, or of the medical man, would detect the disease long before the tenant was able to discover it. Why should not the duties be imposed upon the medical attendant? He thoroughly appreciated the difficulty which the medical profession at the present time had in going to tell tales out of school, so to speak, by informing the medical officer of health that there was a contagious disease in some gentleman's or some poor man's house. The medical men said—and he believed that was the feeling of most of them—"Make it compulsory on us to give the information. Make it a duty which we owe to the state, and we will do it." At present one would tell and another would not, and the consequence was that medical men got into disgrace. The only way to bring the information to the medical officer of health was to impose the duty upon the medical attendant. He (Mr. Marshall) did not think that sufficient notice had been taken that day of the difficulty of isolating a case of contagious disease when it was discovered. They must do one of two things—either keep the patient in the house, and empty the house of other people, or take away the patient. That fact seemed to be not sufficiently attended to. The gentlemen assembled were supposed to be persons who stood, so to speak, in the front rank of sanitary progress, and they had no doubt as to the means which should he carried into effect, and which, perhaps 50 years hence, all the community would agree to; but in legislating on matters of this kind, unless they could carry the community with them to a very great extent, they would find impediments in their way rather than find that they were assisted in their work. If they legislated in the direction of public opinion, they would have public opinion with them, but if they proceeded to go beyond a certain point, they would have the very community which they sought to benefit taking the position of obstructives to them in every direction. The point to be considered in any further legislation on this subject was, how to hit the happy mean—how so to promote the object that they all had at heart so as not in the long run really to retard the improvement which they hoped to see effected. He agreed with the speaker who said that they must look rather to the education of the people, and indoctrinate them into true sanitary science, and then they would not have

such an exceptional case as they had there yesterday, of one gentleman denouncing them all as quacks and impostors.

Capt. Douglas Galton C.B., F.R.S., said that he rose to say one word with reference to the motion which his friend, Mr. Chadwick, had proposed. He did not know whether that motion had been seconded, but he thought that it would be inexpedient to pass such a resolution. But the fact was, that it was very difficult to have inquiries of that sort conducted by a Parliamentary Committee without a great organisation to collect evidence, and without considerable expense. And, in fact, those who would come forward to help the inquiry must put themselves in a position of considerable antagonism to the Local Government Board, and this he thought would be a very undesirable thing. But he thought that all the arguments which had heen adduced with respect to the Local Government Board pointed chiefly to defects in its internal arrangements, which might probably be met by themselves, but he thought that they also pointed very strongly to the view taken by Mr. Cresswell in his paper, that the Board should be decentralised, that is to say, that they should, so far as possible, remove from that Board everything to which could be given a local character, and reserve to the Board the duty of generally supervising the local administrations. He thought, as Mr. Cresswell put it, the new county financial board should be able to do the work of local supervision, not only sanctioning loans, but granting them out of local funds contributed within the district. He was sure that, if that were so, they would have a much greater security, that the money would be well spent, and they would ensure that those engineers who were employed would be looked after in the best manner. He did not share the belief that engineers endeavoured always to live upon the community that employed them. He believed them to be most anxious always to do their duty to their clients; but there was no doubt that with them, as well as everybody else, it would be very much better that they should be looked after in the work they did.

Mr. North, Medical Officer of Health, said that he should like to say something on the principle involved in the question before the meeting, which seemed to him to be whether it was desirable at the present moment to call for more compulsory powers from the Legislature than were at present enjoyed. If he understood the tone of the speakers who had advocated that proposition, it was that they thought they would at the same time secure some diminution of central authority. It seemed to him that if their compulsory powers were increased, that increase would of necessity have a contrary effect, and increase rather than diminish the power of some central authority, because if local boards at the present moment would not go beyond the opinion of those who elected them, it would not be likely that they would be induced to do so simply by the insertion of compulsory clauses in an Act of Parliament; and it would be all the more necessary that there should be some central body to make them do their duty. He thought the result would be that the central authority would be greatly increased in power, and that the end which was aimed at, viz., decentralisation, would not be attained. He spoke with the experience which he had derived from being a good many years a member of a corporation, and he thought that their compulsory powers were in many points sufficient at present. If they increased them more than they were now, the only result would be that corporations and local authorities would, by the necessary enterprise of the central authority, be, to a very large extent, shorn of that freedom of action which he thought was necessary. The principle of all local government was that ratepayers should elect their representatives, and no legislation could carry them beyond the state of opinion of those who elected them. If large constituencies, numbering hundreds of thousands, were not able to rise to the standard of what sanitary science required, all they could do was to wait patiently, and hope that in time they would be educated to a better appreciation of what was required. He did not think that any alteration of the law was necessary, and he believed that existing legislation was sufficient to bring about a large amount of good throughout the country. The people were becoming, month by month, and week by week, more largely informed as to sanitary questions and requirements. He would say in this matter, as in others, "Rome was not built in a day," and the generation that came after them would reap the reward of the legislation and labours of the present.

The President—Now, gentlemen, an extremely difficult task devolves upon me, which it is really impossible for me to perform as effectually as I should desire; and that is, to endeavour to sum up, as far as I am able to do so, the discussions which have taken place, at any rate, to-day. Now, that is an extremely difficult task, because the subject itself is extremely wide and complex, and because the discussion of that subject has been wide, comprehensive, and even in some respects occasionally discursive; all that I can do, is this, to endeavour to draw your attention to those points which I think first in order of importance and saliency, and to be content to leave many minor matters, many valuable suggestions of amendment which have been made, somewhat in the background and in the shade. I would say, in the first place, with reference to the specific amendments of law which have been proposed, without dwelling further upon them, that the Public Health Consolidation Act of 1875 has this merit, that it divides the subject matter, which is really local government, into various chapters under various heads. It is called the Public Health Act, but it really is a Local Government Act. It divides that subject matter into a series of parts, and this is a very convenient division, and was intended as a convenient arrangement, with a view to future amending legislation, so that any private member may know how to deal with the matter, and may understand that if he wants to carry out, or propose to Parliament to carry out, a certain amendment in the law, he has only to look for that part of the Act of 1875 which contains the subject matter upon which he desires to legislate, and he need not look beyond the four corners of that part of the Act. It is not necessary that he should make himself exhaustively, and critically, and legally familiar with every other part, and with every other section of the Act. I think it is fair to say this with reference to the construction of that Act. I should add that the difficulties of legislation are of two kinds. There is first of all the difficulty of knowing what amendments to propose, but there is, secondly, the difficulty both for Government and for private members of carrying legislation through the House of Commons, and that is a very rapidly increasing difficulty. As to private members it is almost an impossibility. But you will tell me, perhaps, that Mr. Alexander Brown has had the good fortune to carry through the House of Commons, at any rate, the Public Health Act Amendment Bill of this year. That is true, but that was not the Act of Mr. Alexander Brown alone. It was effected because the department of the Local Government Board was willing to be assisted by Mr. Alexander Brown, and to assist him in passing that Bill, and it is only by that kind of common consent that that Bill has passed the House of Commons, and without that common consent it could not practically in point of time have been carried, so that we must, to a certain extent, moderate our views and expectations in that respect. Now, that brings me to another and a distinct proposition, very ably argued upon the part of Mr. Alcock. He objected to bye-laws upon many grounds, which have something in them. He said that after all a question might constantly or frequently arise whether a bye-law was a legal bye-law. I may, perhaps,

say to him, in reply, that questions very frequently arise as to the meaning and interpretation of the section of an Act of Parliament, so that after all that is not a conclusive objection against bye-laws. But one reason in favour of bye-laws is this. Mr. Alcock's suggestion was, that you might have a building Act for the whole country outside the metropolis, and that that could be applied, or partially applied, under the sanction and discretion of the Local Government Board, to the various local areas and authorities in the country. Well, now, I can assure him that it would be almost an impossibility, even for a Government department, to pass in the present state of affairs, and in the present temper of Parliament, an Act of that description, going into all the details of building operations, and that, practically speaking, we have no option with regard to this kind of detailed legislation, but to legislate by deputy; and bye-laws are legislation by deputy. What we have to do, therefore, it appears to me is this. So far as the Public Health Act may have been deficient in conferring powers either on the Local Government Board or on local authorities, then, in the fewest possible words, and in the simplest possible way, amend that Public Health Act, and then, under that amended Act, pass bye-laws for the approval of the Local Government Board, which would be efficient for the purpose for which they are conceived. That a good deal can be done in this respect is, I think, undeniable, from the fact that I have in my hands a series of model bye-laws issued by the Local Government Board. It may be fairly assumed that these model bye-laws, with perhaps some exceptions, would stand legal criticism in courts of law. And here you have a series of model bye-laws which deal with almost every subject of local government. You have the first on the cleansing of footways and pavements, the removal of house refuse, the cleansing of earth-closets, privies, ashpits, and cesspools. Then you have others. I will not stay to enumerate what they are, but I think there are six or seven of them, and they practically exhaust the subject matters of local government administration. I think I may make a good practical suggestion; I would make it to Mr. Alcock and other members attending this Conference; I would suggest to them to take this bundle of model bye-laws, and when we meet again next year be prepared with specific written statements of the deficiencies of those bye-laws, and of the way in which those bye-laws ought to be amended, and also of whether additional legislation would be required in order to enable local authorities to pass, and the Local Government Board to approve and confirm such amended bye-laws. That, I think, would be a very good practical subject to suggest to many of our practical and scientific men at the meeting next year. Well, then, I would come next to the speech of Dr. Syson; and I come to that next because I shall have to express a decided difference of opinion, and I think I had better express it at the beginning. I will say, before I express it, that I do not believe there is much difference of opinion when we get to the bottom of our ideas, and that I have often found that people imagine wide differences to exist between them, when the real fact is that they have not always sufficiently ascertained the meaning of the terms they use, or the amount of agreement in opinion which possesses their minds. Now, Dr. Syson made a speech with the general tenour and thought of which I think I almost entirely went; but he made one suggestion with which I can not agree, and I will give the reasons why, and I am mistaken if those reasons will not prove satisfactory to Dr. Syson himself. He proposed, as the great necessary and preliminary improvement in imperial administration, that you should separate the imperial supervision of poor-law administration from the imperial supervision of local government administration in the country. That, I think, was Dr. Syson's recommendation. Well, now, that is to say that you should repeal the Act which added the Local Government Office and the Medical Department of the Privy Council to the Poor-law Board, and which transformed the Poor-law Board into the present Local Government Board. Now, that Act was mine; I am responsible for it, and, therefore, it is natural that I should defend its policy. Well, to defend the policy of that Act is really to go into the whole question of organisation, which has been raised mainly by the paper of Mr. Cresswell to-day; and I will endeavour to deal with it in regard to certain propositions of his. But I will say, in the first place, that it could not promote simplicity in organisation, either imperial or local, according to my view, if you were to separate either the local administration or the supervision of that administration of the poor-law from local government administration or law. Now, for instance, in poor-law administration all the sanitary questions arise which have to be considered in what we call local government administration. You must build your workhouse in accordance with sanitary regulations, and you must deal with your paupers and with your workhouses in accordance with sanitary laws. You cannot have a poor-law administration without that local administration having sanitary and medical functions to fulfil in connection not only with the building or regulation of these establishments, but with the dealing with the diseases of those who are paupers, and who, therefore, come under that local administration. Therefore, I think that it will be quite clear—I go no farther than this at the present moment, but it appears to me to be quite clear—with reference to an ideal organisation in the future, that that cannot be the true and the right idea that would separate those two things which are really part of one thing; that is, the local government of any particular area of the country as a whole. And the idea to which my mind has already tended, and by which it has been governed in any legislative or other proposals that I have been connected with, has been that you should concentrate all the functions of local government, of whatever kind, in one governing body in the largest area for which those functions were fit. That is, I think, the principle which will, in the end, lead to much simpler organisation of administration than any division of those functions. Well, now, I will endeavour to explain those views in a little further detail, and I will commence with the paper of Mr. Cresswell, which made various proposals. The first was, the employment of the ballot in the election of members of local boards; that is to say, of urban and rural sanitary authorities. Well, the subject which is really raised by that proposal of Mr. Cresswell's as it seems to me, is a little wider than the question of the vote by ballot. It seems to me to be the question of the method of constitution, as well as the method of election, of those various local governing bodies. You may have election by ballot, supposing that to be a cure for all the evils to which he has referred; but if you have that election within a very small area, accordingly, to my experience, you are not likely to get a board which you can trust to perform the critical and responsible functions of local government, especially with regard to health. In my view, it is of the greatest importance that you should, as far as you can, enlarge the area of local government, and that you should set your face, as far as possible, against the multiplication of those small areas and small boards, who cannot be trusted to fulfil their public duties. Well, then, if that is the first proposition with regard to the organisation of local administration, the next thing that occurs to one's mind is this: by what further proceeding can we promote the independent character and the public efficiency of such governing bodies, and the next principle which has always occurred to my mind is this—that you should endeavour to interest the best men in every district; for the great practical difficulty in these days is to get the best men in your neighbourhood to undertake public local duties. They are weary of the petty and commonplace functions of ordinary local government, and you

cannot get them to do that work. Well, then, the only way to get them to do it is to ennoble it, and the only way to ennoble it is to enlarge it, and the way to enlarge it is, first of all, to enlarge the area, and then to enlarge the functions, and thus, then, you would enlarge the functions in all ways. Then you would have a fit area, and a competent authority elected by the inhabitants of that area; and I entirely agree with the two last speakers in the view that we can build up nothing which we can trust in the long future which is not built up upon the lines of local self-government. I do not believe in promoting or securing the health of the people *ex cathedra*, or from above; and I consider that the question of health is very largely an educational question. Well, then, one way in which you would, as I say, enlarge and ennoble the functions of boards of this kind, would be to say that, in every local governing area, the local governing body should be the local governing body for all purposes, and then it would come to pass that the details of what we have been accustomed to call sanitary administration would be entrusted to competent and sufficiently-paid officers; and that is the principle adopted by all business men who succeed in business. A man begins to make his fortune by doing everything himself, but after he succeeds, he ends by doing nothing himself, but being simply an organiser of a great machine which goes almost by the touch of his finger. Well, now, we ought to have the same principle in the organisation of the local board. If you enlarge the functions, and give higher functions, you give an inducement to good men to go upon that board. There are some men who do not care for the simple subjects of ordinary town councils, but give them the subject of education to deal with, and I say you will tempt such men to come upon the boards. Therefore, I say, the philosophy of the thing is perfectly clear—that, first of all, you have to get the largest areas that you can and that are fit for particular functions, and then to attribute all those functions, for which you have got a fitting area, to one governing body; then to get at the best mode of election; then to give that governing body as much independence as possible of the imperial authority. Dr. Syson will see that it is a necessary consequence of that general view, as far as I am concerned, that you should not separate poor-law from local government administration in the locality; and, if you do not separate it in the locality, you cannot separate it in the imperial department which is to supervise both of these subject-matters of local administration; and I think that I shall be able to show you, before I sit down, that it is by no means necessary, in order to simplify the proceedings of the Local Government Board, that you should subdivide, but that, on the other hand, to subdivide it would be to increase its complexity; and it is by no means impossible so to organise its business that it may be conducted, as a great business ought to be conducted, simply, efficiently, and without loss of time. Well, then, perhaps the next subject in one's road of thought is this. We have got these units of local administration, as I may call them, as large as we can; but there are certain functions for which those areas are not sufficiently large, and then you must create larger areas for those special functions, and then we come naturally to the question of the creation of county boards. We are brought, without reference, to further questions, naturally and directly to the notion of the creation of a county board. Now, county boards have been advocated to-day from several points of view. First of all, there is the fact that there are certain functions of local government which could hardly be efficiently exercised on smaller areas. You have the management of roads, and you have the conservancy, and the prevention of the pollution of rivers. Now, I think I said, in my opening remarks, or at some period in the course of the discussion of yesterday, that I had supported or approved of the passing of the Rivers Pollution Bill, because it established legislatively the proposition that the pollution of rivers was to be prevented. It provided the method of that prevention; but if that method of prevention did not succeed, the case would be complete for the passing of an Act to improve it. In the great legislative pressure in which we live we often have to consent to that mode of legislation. We get a Bill through making, as it were, confession of a fault, and containing, perhaps, an imperfect remedy, and then you can improve that remedy at some subsequent time. Anyone must have known, on reading the Bill, that it could not work, because the machinery led to such complexity, and seemed contrived ingeniously, to set the whole country by the ears, and to set authority against authority, and riparian owner against riparian owner, up and down the stream, all over the land; so that the end was that clauses had to be inserted forbidding anybody to take advantage of the Act, except with the leave of the Local Government Board; and that is about as complete a confession of the unfitness of the Act for practical purposes as, I think, could be found on the face of any statute. Now, the true solution of that question, according to my impression, is the creation of county boards. I know many scientific men have said that even that would not be a solution — that you must go beyond the county and have watershed authorities, and I do not deny that there is a great deal in that view; but, first of all, you must have the county boards for other purposes. You must have them to complete the structure of the edifice, as it were, and to enable local government to hold its own; and, therefore, having the county boards, I would put upon them the question of preventing the pollution of rivers, and of the conservancy of rivers, as far as they could perform that function. I would give powers to certain county authorities to unite and form watershed authorities, where it might be desirable, with the sanction of the Local Government Board. Well, another point of view raised, I think by Mr. Cresswell, was that the county board should stand between what I may call the unit of local administration or Local Board—in fact, the urban or rural sanitary authority—and the imperial supervising department; and that the county board should take upon itself, or should have allotted to it, a considerable portion of the powers now exercised by the Local Government Board. Now, I am not disposed to express a definite opinion at this moment upon the extent to which that idea might bear fruit in the future. I do not hesitate to say that it is an idea which will bear fruit in the future; but I am not prepared at this moment, and I do not think it desirable at this moment, to say to what extent, because my view of the matter is this. I have expressed it in Parliament, and I will repeat it here. The true way, in constructing organising measures, is to plant an institution in some natural soil, to give it enough to live on and to work for, and to give it time to grow. If we were to get a number of experts together, and say, "Now, draw us up the clauses of a Bill to constitute county boards, and tell us all the functions that those county boards ought to undertake, and let the thing be so perfect that, as far as local government is concerned, it is the millennium brought to our own day," the result would be, first of all, a Bill which you could not pass, and then which you could not work if you did pass it. But what you will do, if you create county boards, is this, you will at once change the centre of gravity of the whole system. Now, in that expression lies the secret of the whole thing. The moment you have created the county board on proper lines, and given it enough to go on with, you may depend upon it that by a force analogous to that which enables larger bodies to attract smaller bodies to them, it will attract to itself many of the functions of smaller governing bodies which are now inefficiently performed, or it will at least attract to itself some sufficient supervision over the performance of those functions. Another good thing it will do in altering the centre of gravity of the system is this: you will have a different

idea in men's minds, and the repute, in fact, of local government will be altered and raised in the public and in the legislative mind, when you have once created and set to work large boards with considerable functions like county boards. You will then have boards which can not be dealt with in the same kind of way in which smaller boards are dealt with. They will know how to hold their own against any governmental body, and there will be a natural tendency on the part of smaller boards in the county to aggregate round them, and to appeal to them for protection and for help. But to enable the scheme of county boards to affect these purposes the scheme must be built up upon the right lines. Now, I approve of the ballot, I approve of direct election by the ratepayers; but what I care about far more than those questions at this moment is the areas upon which you should elect and return the members to county boards. The fault that I find with the Government Bill —and it is a fault that I have found within the House, and I have put down an amendment on the paper to meet it, and I have much support upon the Government side—is this, that they propose that the election should be made upon the area of the petty sessional division, and I propose that the election should be made upon the local government areas within the county. Whether the election be direct, or whether it be an election to the county boards of the various subordinate boards within the county, that is a secondary consideration. If you have the elections taking place upon the fitting areas, you will have a county board which will feel that it represents each administrative area within the county, and you will have all those administrative areas feeling that they are represented on the county board, and the two will be able to come together and coalesce, and to strengthen each other, and to play that part in the revivification and the strengthening and consolidation of local government, which we desire that they should conjointly play. Well, then, as far as that question is concerned, I have sufficiently explained my view with this exception. I would refer to a remark of Dr. Child, which struck me as very appropriate. He talked about the confusion of authorities; I did not at first catch where the confusion of authorities was, but he gave an illustration, and certainly it has thrown to me a somewhat new and additional light upon the question. He says that within a particular area, while you may have only one sanitary authority, you may have three or four, or five judicial and interpreting authorities, and that there is very great mischief. You may have one law, you may have one compilation of bye-laws, to administer over a particular and a large area—a union, for instance, or a rural sanitary district to which those laws are applied. But, if that area happens to be situated within three or four different counties, those laws will be interpreted by three or four different benches of magistrates; that is to say, by three or four different magistrates' clerks, and there is a confusion of authority which certainly had not occurred to me before, and that is an addition to our information upon this subject which we have got from Dr. Child today. Therefore, for all reasons, we want simplification of areas, and that is another merit which the constitution of county boards possesses, that the moment you constitute a county board it will dominate the whole question, and every one will feel that every area must be brought within the area of that county board, and that all crossing of areas must be avoided. And when you come to that, you will have attained the simplicity which is so necessary for the purpose of good local government. Of course when you do that, there are various things which will have to be carried out. I will take two cases. I will take, first of all, the question of highways. Well, you must know that highway areas differ from the sanitary areas. This is folly—it really is foolishness—to persons accustomed to study this state of things. It may do for the time, but it will not do in the long run. The local sanitary authority, whatever it is, ruling a particular area, must rule that area for all local government purposes, unless it is for purposes for which that area is too small, and then the simple principle which you have to bear in mind is, that there should be a multiplication of those various areas without the crossing any two of them. Then the other legislation that I would add is legislation with regard to the Poor-law. Now when I framed the Public Health Bill, and constructed those sanitary measures, my mind went further than the clauses of that Bill, because one cannot always put into a Bill everything which one has in one's mind, or looks forward to in the future. I had then this principle in my mind of the simplicity of local administration, all functions, if possible, in the future in one governing body in one local area; and if you will consider the thing for a moment, you will find that, complicated as it appears, it would be the simplest possible process, at some future time, to effect that simplification, as far as the Poor-law is concerned. There is no reason why the Poor-law administration in localities should be severed from other local government administrations. There are many local government areas far too small for many parts of the Poor-law administration. For instance, for the management of a workhouse, many local areas are too small; but as soon as you have the local government area too small for a particular Poor-law function, all you have to do is to construct a body ruling over a combination of those areas for the performance of those functions. And, to give a further illustration, you may do it in this way. It is perfectly conceivable, in order to complete that idea of simplicity of organisations, that you might have out-relief managed within your local government areas as they exist, and that you might have in-door relief managed by the present unions, or even by the county at large. Those things are perfectly conceivable. It is not necessary that you should come to any opinion upon them now; but as soon as you have adopted that principle in your organisation of areas, that there is to be no crossing of areas, and that you have all local government functions which are fitted for a particular area imposed upon one governing body in your area, and that you admit of no larger area with local government functions which is not simply a multiplication of those units, then you have got an arrangement which enables you to meet any present or future exigencies with regard to the execution of those functions, and without the possibility of confusion. Well now, I will say a few words more. Mr. Cresswell referred, in speaking of imperial administration, to several cases in which local bodies have been informed, as I understand, by the Local Government Board, that they could not be assisted in any methods of getting rid of water-carried sewage, save that of land irrigation. And, on the other hand, our attention was drawn to the report of the committee of the Local Government Board, of which Mr. Rawlinson was himself a member, in which they distinctly admit that land irrigation is not possible in every case, and that there are towns which can not deal with their sewage by that process. Well, I am not able to reconcile that apparent contradiction, and I think that I ought to say, with reference to some remarks which have been made, and which have been rather strong in their character with regard to the Local Government Board, that all the remarks which are made here ought to be made—and I trust they will in future be made—with the kind of reserve which should arise from the fact that, after all, we only know one side. I am not prepared to say that there is not an answer to this apparent contradiction. I am not prepared to offer an opinion upon the subject; but it is clear to me that no public department ought to take upon itself (if it does do so) to inform local bodies that there is only one method of dealing with their water-carried sewage, which is acceptable, or admissible or permissible, and that is by land irrigation and filtration. Now, I should like to say a word upon the Local Government Board itself. First of all, I may

say that, like our other great departments of the State, it is admirably served. Now there is no question about that. What I shall say to you upon that subject I shall say with the most complete candour, and I shall tell you exactly what I think. It is admirably served. There is no department better served. You have men fit for all work which you want them to do. The question in my mind is not the fitness of the men, but the organisation of the department. It is admirably served. I am not prepared to say that the deficiencies in its policy of organisation and of administration are consequences of its not having had enough money given to it, or enough power conferred upon it by law. But I am prepared to say that, without adding another clerk to the establishment, and without giving the Board any additional power by an Act of Parliament, a very considerable change for the better may be made in the policy of its administration. The remarks upon that head which I shall make are not new, as far as I am concerned. They will be expressive of opinions which I havo entertained since I was President of that Board, and which, as far as time permitted, I put in force when I was president. Now, to go to the bottom of the matter. In my mind it is that there is a tendency in all Government departments to become merely secretarial departments. That is to say, they do not understand that they are administrators, and that they have to drive their work; but they do understand that they are secretaries, and that they have to answer the letters which come to them to be answered. Now, that is really almost the secret of the whole thing. They are full of distrust of what I call administration. They do the very reverse of what a successful man of business does. A successful man of business begins by doing everything himself. As he goes on and enlarges, he organises his business. He subdivides it into branches. He chooses his men, and if a man does not suit him he gets rid of him. I know that it is not easy for a Government department to do that. I have to make that allowance. But when a man of business has got a man who suits him he trusts that man. Now, that is precisely what a Government department hardly ever does. It is what a Government department of this administrativo character ought to do, and, in my opinion, could safely do. It is a question of organisation. It is a question of the administratlon of a business. But, as Mr. Chadwick told us to-day, and qnite rightly, a politician going in at the head of that Board, however practical his vicws of administration might be, has not the leisure whilst he is there, and in all probability he will not be there long enough to do what has to be done. And now I will put before you my first suggestion, and it shall be of an extremely practical and telling nature. The very first thing I would do is this. I would here ask myself "Who is the permanent head of the department? What is he called, and how is his business managed?" Looking in that way, I should find that the permanent head of that department was a secretary; I shonld say that will not do. I should say what I said when I was therc. The permanent head of the department has no right ever to have a pen in his hand. He ought to do like Count Moltkc was said to be doing at the beginning of the German war—walking about his office with his hands in his pockets and whistling. The hcad of the department ought to be an organiser. He ought to rule policy. He ought to see men, and he ought never to put his pen to paper. Now, it is impossible for me to speak too highly of the abilities or of the labours of the men who gather around that extremely able public servant, Mr. Lambert, of thc Local Government Board. But when I go there, as I do occasionally, to consult with him, I feel a delicacy in entering his room; and though I do not wastc his time, because I am sufficiently familar with these subjects to go direct to them, yet I feel that every moment that I take of his time is more than he can afford, because, with regard to him and some of his ablest assistants, I may say that if you go into their rooms you can hardly see them for the papers that surround them. That is unsound, and what is the result of it? Why this is the result of it, and I found it so when I first went. You have always an arrear of papers. You have a dead weight of papers. You let your work drive you instead of driving your work. You get au accumulation of papers. You sit with them up to the top of your head, and you are constantly striving in vain to get down your work. You are constantly behind your time, and it is a well known fact that delays aro increasing in the Local Government Board, and that, in spite of the merits of the men who serve it, and I was going to say in spite of the enormity of their labours, they cannot keep up with their work, and they cannot prevent causing dissatisfaction in the country. Well, there is nothing but organisation that can get over that, and tho first step of that organisation is that the permanent head of the department shall not be a secretary. He should be a manager. Call him, if you like, the permanent Vice-President of the Board. I do not care at all about names, I want thc thing. I want the man who shall administer, and who shall leave to others the duty of recording on paper the conclusions at which he and his subordinate administrators arrive. Well now, if you had such a man, how would he naturally set to work. Well, it is a very complox subject, and it must be a very complex machine which such a man will have to supervise. He has to deal with poor-law questions, with legal questions, with engineering questions, and with medical and chemical questions. Why, such a man would gather around him the heads of those various departments, and he would consult with them upon the general policy of administration, and he would create, and he would secure, the permanence and the continuity of that policy of administration. Then, how would you carry it out? Supposing you conceive your policy of administration—your policy of business—to pursue my analogy of business—how would you carry it out? I will come to the secretaries, but I would not think of them, even in the second instance. I would, in the second instance, think of my local representatives, that is to say, the inspectors of the board. You have general inspectors for what you may call legal purposes. You have medical inspectors and engineering inspectors, and what you want with regard to these foreign representatives of yours—your ambassadors, so to say, to the powers in the country, the local authorities with whom you have to deal—is this, you want to organise the relations of those various classes of inspectors in such a way that, just as we have proposed that there should be no clashing of areas of local authorities, so there should be no clashing of imperial departmental supervision, and then you will get that simplicity of imperial administration which I have always stated is required in local government in the country. Supposing that to be done, do you not think that one important result would be this, that you would immediately, at the Local Government Board, find an immense diminution of that amazing and unprofitable paper correspondence which they carry on? I would do nothing by a letter which I could do by a man. But precisely the contrary principle obtains, and is believed in by local departments, because it is the tradition of all those departments. Their tradition is a fearful tradition. They fear responsibility, and they write lawyers' letters, conveying no information and putting other people in the wrong. What they ought to do, as has been said to-day, is to nurse, to back up, to encourage, to inform, to help. While I was there I had one little scheme of my own. I mentioned it before. I think it would have been a very good one. Little things sometimes go a great way, for they tell a tale. I had no room to do what I wanted, or I would have done it. I wanted to constitute an inquiry department. Now, you have men in the Local Government Board who are extremely willing to give information, simply

because they are good public servants and good men, but I would have in that office a department devoted to the subject of affording information to the public who inquire; and I think the result of creating such a sub-department would be extremely advantageous upon the whole spirit of the administration of the Board itself, and upon the spirit of the public, and the confidence of local authorities wanting information and applying for it. I think that it would be understood to be a step in the right direction, and a hand held out to those who ought to be helped by the department created for the very purpose of helping and strengthening local bodies in the execution of their duties. Well, as far as I can recollect, I have now about exhausted that subject, and I hope I have made myself tolerably clear. There are many other questions upon which I could go back—questions, for instance, which were discussed yesterday and this morning; but if I interpret your minds and views rightly, I think you would wish that we should close this Conference with the remarks that I have endeavoured to make upon the discussion that has occupied the latter part of our time, as after all it is the biggest subject. It is the subject of the true solution of all those questions, and I do not think that there is any subject so profitable or so interesting, on the whole, for your consideration and for your conclusions. Now we have before us a proposed amendment by Mr. Chadwick, and I think we had a proposal from Mr. Cresswell in favour of the constitution of county boards. I am not sure whether Mr. Cresswell put that forward as a motion or resolution, which he proposed to pass.

Mr. Cresswell—I said, Mr. President, that I hoped that this Conference would not separate until they had recorded by a resolution in general terms, their desire that you would be the interpreter of their feelings, both in Parliament and out of it, in conjunction with the Council.

The Chairman—I will take that as a motion. I do not know whether I am to take Mr. Chadwick's as an amendment upon that motion.

Mr. Chadwick—I intended to put it as an original resolution, but as my friend, Sir Henry Cole, does not seem disposed to meet the challenge that I have given that those gentlemen I referred to could sustain their allegations with respect to the Local Government Board, I am ready to withdraw the motion, but will leave the matter with them.

Sir Henry Cole—I confess myself in rather a fog. Mr. Chadwick let off a gun, and asked me whether I seconded it. I had not considered it. He proposed a Parliamentary inquiry into the Local Government Board. I do not agree with that, and I agree in the objections that were made to that mode of proceeding. I much more agree in the Chairman's essay upon local government administration than upon an off-hand resolution of that kind. But you know that Mr. Chadwick does do things in that way. I am very sorry I could not answer at the instant. It was "stand and deliver."

Mr. Chadwick withdrew his amendment, as it was evident that the complainants were not ready to sustain their complaints without further consideration; as, indeed, proceeding upon them here would be sectional, and they might form part of a larger suspending inquiry pressed on other grounds from other quarters.

The Chairman—Well, then, I think that Mr. Cresswell is going to propose a resolution, and I think that if it meets your views, you cannot do better than conclude by passing the resolution which he is going to propose.

Mr. Cresswell—Then, gentlemen, the resolution I beg to propose, as a practical conclusion of this Conference, is to the following effect:—"That this Conference desires to record its opinion that further legislation is needed, especially with regard to the constitution of county boards, with a view to strengthen the Local Government administration, and authorise the Chairman in conjunction with the Council of this Society, to be the exponent of its views on this subject, and to lay the subject before her Majesty's Government in such manner as he and the Council may deem most expedient."

Capt. Galton—I beg to second this resolution.

The resolution was carried unanimously.

The Chairman—Here is a resolution brought forward by Mr. Robinson and Mr. Shoolbred. Had it been possible to ask for your attention to a new subject, it would have been very worth to discuss it, but I think that it is hardly practicable at this time of day, and I think that it must be deferred.

Dr. Syson—I may take this opportunity to propose that we should thank our Chairman for the able and efficient manner in which he has conducted our proceedings. If we had only had that summing-up, that of itself would be sufficient to bring us here. I consider that summing-up worthy of the whole four days' labour. I wish we could send politics beyond Turkey, and put our Chairman as a permanent administrator, at least for our time, of the poor-law and sanitary administration of the country. I think that peculiar thanks are due to him for the very able way in which he has guided us, and for the admirable summing-up of our opinions in his closing remarks.

Mr. Chadwick, in supporting the vote of thanks to the Chairman, stated that it was satisfactory to observe that the right hon. gentleman must, in these discussions, have learned much for his future guidance in legislation, and for safe administration, which it was quite impossible he could have learned amidst the turmoil of party conflicts in Parliament during his short tenure of office at the Local Government Board—for the service of which he had much yet to learn, by coming amongst them, that might impart the full special aptitudes required for the administration of the great branches of service there, when, in the fulness of time and the change of parties, he might return to office again. Unhappily, however, in the usual course, if such an event were to happen, it would be that he might be sent to some office, where the appropriate information he had acquired would be of no use whatsoever. Nevertheless, they would be of use for aiding in current legislation.

The motion was submitted by Mr. Chadwick, and carried by loud acclamation.

The Chairman—My only remaining duty is to return my thanks to my friends, Dr. Syson and Mr. Chadwick, for the extremely kind way in which they proposed the vote of thanks to me. I should add my thanks to Mr. Cresswell for his too flattering allusions, and I must thank you all for the equally flattering attention which you have paid, and for the very kind interpretation which you have placed upon my endeavours to serve you upon this and upon former occasions. I now declare this Congress at an end. I hope that the Society will kindly consider the suggestion which I made at an earlier period, of somewhat enlarging its scope in future years; but in any case I trust that it will be followed up, and be an Annual Conference for many years to come.

NATIONAL WATER SUPPLY.

The following are some of the communications brought before the Congress, held on the 21st and 22nd May:—

CHARLES E. DE RANCE, Assoc. Inst., C.E., F.G.S., H.M. Geological Survey.

The need of providing our rural population with a supply of wholesome water, as suggested by his

Royal Highness the President, becomes daily more urgent.

The existing sources of supply in the rural districts are shallow wells, flowing streams, and other surface waters, which, through increase of population, manufacturing requirements, and agricultural operations, are steadily becoming more and more hopelessly polluted, while the quantity required for use is in most districts steadily augmenting.

The sources of supply in a given district being necessarily limited, the struggle for the possession of water rights in a populated area is annually becoming keener, and the Parliamentary and other preliminary expenses larger and larger, small and struggling townships having, in some cases, to borrow several thousand pounds for expenses incurred, before any powers are granted by Parliament to commence engineering works; and in one, a township near Bolton, when such powers were actually refused, though the population was and is still suffering from a short and polluted water supply, which is the constant source of typhoid fever.

Other townships, who from ignorance, apathy, or want of funds have neglected to be represented, when projects for the supply of the neighbouring districts were laid before Parliament, have awoke to the necessity of providing themselves with an efficient water supply, only to find every available source cut off, and the part of the natural watershed due to them, the legal possession in perpetuity, of the inhabitants of another district.

Hitherto the inquiries into water schemes, held by inspectors of the Local Government Board, and by select committees of both Houses of Parliament, have been mainly directed to ascertain whether the project was a good one for the *district in question*, especially when the promoters of the Bill were the Corporation, Local Board, or sanitary authority, seeking water for the good of their district, and not directly for the purposes of profit.

These officers and committees have neither time, opportunity, nor the advantage of professional assistance, to examine the district, and ascertain, not merely that the scheme is good, but that no better one could be devised; and what is, perhaps, still more important, there is no machinery at their command, to ascertain how far the interests of other districts, which may possibly be wholly unrepresented at the inquiry, are endangered.

An inquiry on the ground should be held in all cases where schemes for water supply are proposed to be laid before Parliament, and not merely, as is now the case, when the local authority seeks water-powers through the aid of a Provisional Order of the Local Government Board, the staff of which might be, with great advantage to the nation, so increased, that not only every scheme for water supply laid before it might be subjected to a searching local inquiry, but that its officers should make an examination of the whole country, and that the Local Government Act of 1875 should be so modified as to admit of more speedy legislation than is now the case, and to give to the Board* power to compel local authorities and landowners to construct works in all districts where the officers of the Board found, on their survey, a water supply needed, and none in process of formation.

The Committee of "Inquiry into the New Red Sandstone and Permian Formations of England, as a source of water supply for towns and districts," appointed by the British Association, at their Belfast meeting in 1874, with the writer as secretary, have obtained a large amount of valuable information as to the large volume and pure quality of the waters derived from these formations, and are now extending their labours to the Jurassic Rocks, from which so large a volume of water is derived, and which the Rivers Pollution Commissioners describe as next in excellence to those from the New Red Sandstone. Information has been procured, by the circulation of a printed form of inquiry, by members of the Committee, in the particular districts with which they are acquainted, and of which they have taken charge. The experience arrived at during the four years' work is, that though much information can be obtained by circulation of carefully-worded forms, yet no definite opinion of the quantity of water capable of being yielded by springs and deep wells from permeable rocks can be arrived at, without the careful survey of the district in detail by a trained geologist, whose whole time should be devoted to the subject; and, in the opinion of the writer, it is a national necessity that a survey of the country should be undertaken by geologists, who should be connected with the Local Government Board, and able to advise with the officers of their existing staff, as to the practicability and advisability of the schemes that may be brought before that department.

As an instance of the urgent necessity of Bills not being allowed to come before Parliament until they have undergone a local inquiry by professional officers of the Crown, unconnected with the success or non-success of any scheme or counter-scheme, the writer would instance the passing of an opposed private Bill in Parliament in 1875, by which the Local Board of a township near Wigan was empowered to construct waterworks, drawing the supply from polluted sources, on agricultural land, and stored in a reservoir to be constructed in permeable rocks, traversed by faults, overlying old coal-workings, at a cost of £34,000.

The Bill was passed, and the works commenced soon after, but in consequence of the serious engineering difficulties pointed out by the opposition in Committee, the works are still unfinished, and the whole of the money expended; an application has been made to the Local Government, for a provisional order to repeal the clause limiting the borrowing powers to £34,000, and asking for an extension to £105,000 to complete the works, that department has just consented to allow the borrowing powers to be extended to £65,000 on the waterworks of the township in question, to complete the reservoir for storing, what will be polluted water, on a dangerous site.

Towards forming an estimate of the amount of rainfall, which is available in England and Wales, as a water supply for the inhabitants, without interfering with springs like those of the chalk districts, that maintain the dry weather flow of the streams that traverse them, I have endea-

* The suggestion of Messrs. Caird and Ridley, her Majesty's Inclosures Commissioners, as to the advisability of such an alteration of the laws, as to enable landowners to charge their property with the cost of providing pure water to villages and hamlets, quoted by the Rivers Pollution Commission, is important in connection with this subject.

River Basins, with names of chief Streams.	Granite.	Metamorphic Rocks; Cambrian, Silurian; Devonian, and Old Red Sandstone.	Carboniferous Limestone.	Carboniferous Rocks.	Permian Marls and Sandstones.	Magnesian Limestone.	Trias.	Lias.	Oolites.	Hastings Sands.	Weald Clay.	Green Sands and Gault.	Chalk.	Tertiary.	Rainfall of these basins, from Mr. Symons' map, 6th Report of the River Pollution Commissioners.
Northern Coast:—															
River Tweed, &c.	..	..	26	242	..	..	..	..	..	..	..	..	..	..	25 to 30
Rivers Tyne and Tees	..	..	322	2,410	..	207	170	142	183	..	..	..	..	..	25 to 50
Rivers Ouse and Trent.. ..	..	..	335	3,554	30	149	3,041	492	840	..	..	69	930	..	25 to 50
East Coast:—															
Rivers Witham and Ouse ..	..	..	..	..	..	..	6	581	3,701	..	..	437	1,601	..	25
Various streams and Thames	..	..	..	..	..	..	..	170	943	229	379	606	4,237	3,333	22 to 31
South Coast:—															
Rivers Adour and Arun ..	..	..	..	..	..	..	..	..	..	636	281	225	266	14	25 to 40
Rivers Avon and Stour, &c...	..	..	..	..	..	..	..	..	140	..	4	144	1,661	773	30 to 40
Rivers Exe, and Dart, &c. ..	120	261	5	292	..	..	364	59	96	..	..	209	48	..	30 to + 75
Rivers Plym, and Tamar ..	59	444	..	255	..	..	..	..	..	..	..	..	..	..	40 to + 75
Cornish and Devon Rivers ..	209	1,400	..	375	..	..	10	..	..	..	..	..	..	..	40 to + 75
West Coast:—															
Severn, Wye, &c.	..	4,410	138	524	145	..	1,831	1,359	768	..	..	57	16	..	25 to 75
Welsh Rivers:—															
Neath to Clywd	5	3,446	187	674	..	..	52	14	..	..	..	..	..	..	40 to + 75
North-west Coast:—															
Rivers Dee to Duddon	..	572	280	1,693	81	..	1,920	10	..	..	..	..	..	..	25 to + 75
Rivers Esk to Eden	..	529	519	61	602	..	37	10	..	..	..	..	..	..	30 to + 75
Total area of each formation in square miles	393	11,062	1,812	10,080	858	356	7,431	2,837	6,671	865	664	1,747	8,759	4,120	..
Hardness (average) of spring water from these rocks—Rivers Pollution Commissn.	3·0	2·5 6·8& 12·0	19·8	13·1	..	59·7	18·8	30·1	24·4	20·2	27·3	20·2	23·6	22·0	..
Permeable rocks	..	..	Carb. L.	..	Permian sandstones.	Mgnesn limestone.	Triassic Sandstones.	..	Inferior and Gt. Oolites.	Hastings sands.	..	Green sands.	..	Bagshot sands.	..
Partially permeable	Granite.	Devonian.	..	Carboniferous rocks.	..	..	..	Marlstones.	Forest marble.	..	..	..	Chalk.	Thanet sands.	..
Impermeable	..	Silurians &c.	..	..	Permian marls.	..	..	..	Kimmeridge clay.	..	..	..	..	..	..
Wholly impermeable.. ..	..	..	..	Carboniferous shales.	..	..	Triassic Marls.	Lias clays.	Fuller's earth.	Grmstead clay.	Weald clay.	Gault.	..	London clay.	

voured to form an approximate calculation of the area occupied by the different geological formations, in each group of rivers basins, the extents and areas of which I have taken from the Catchment Basin map published by the Ordnance Survey, the geology from the map of the British Isles of Professor Ramsay, F.R.S., just published, which is mainly reduced from the maps published by the Government Geological Survey, of which he is the Director-General.

From the table on the preceding page, it appears that an area of nearly 12,000 square miles in England and Wales is occupied by the more ancient Palæozoic rocks, receiving the heaviest rainfall experienced by this country, ranging from 40 to more than 75, and even up to 130 inches per annum, which is yielded in springs and streams, that the analyses of the Rivers Pollution Commissioners show, have a remarkable freedom from organic impurity, and in a condition of great softness.

The large bodies of water that annually run off the mountains of the Lake district and central Wales belong to this class, and, as far as human consumption is concerned, on a large scale, are wholly lost and wasted. From the exceedingly impermeable nature of the ground, and its steep declivity, the rainfall flows off at once as floods; the dry weather flow of streams of such districts, according to Mr. Bateman, amounting only to one-fourth to three-fourths of a foot per second from each 1,000 acres drained, against 200 to 500 cubic feet per second in times of flood.

From the rapid delivery of the water, evaporation in such districts is small, amounting to about 12 inches per annum, while the impermeable character of the rock causes the percolation to be small, and the springs consequently to be small and unimportant. The great natural reservoirs formed by the great lake-basins of these tracts are fed by the flood waters during and immediately after the rainfall, and until Mr. Bateman's project for supplying Manchester and the towns *en route* from Thirlmere—though many schemes for their utilisation have been proposed—none appear to have had any chance of being carried out, or any use made of the magnificent stores of water accumulated in these regions.

The 10,000 square miles of carboniferous rocks, though supplying large volumes from the *Goredale* and *Millstone* Grits, to the reservoirs supplying Manchester, Liverpool, Bolton, Preston, Blackburn, and numerous towns in Yorkshire, have still a large residue available for use in gravitation schemes.

Over a large portion of the 8,000 to 9,000 square miles, occupied by the *Permian* and *Trias*, not less than 10 inches of rainfall are annually absorbed, capable of yielding a volume of 400,000 gallons a day, these important water-bearing formations, though penetrated by a large number of wells, some yielding two to three millions of gallons per day, have still immense water-bearing resources, in a district of which a large portion is densely populated.

The *Oolites* absorb a large quantity of water, which they yield up in springs of great importance and value, especially if the large quantity of water they give off after heavy rainfalls were stored, as the water now given off is of great purity, but is almost always polluted in streams before it is made available for consumption.

The *Greensands* and the *Bagshot sands* are in some districts of local importance, and might be included in any general scheme, that divided the country up into districts, for the purpose of collecting springs or sinking wells for water supply.

The vast area of the *Chalk* receives over a part of its exposure probably not less than five inches of rainfall annually, percolating into its mass, but in some portions of its area, in the Eastern counties, it is so overlaid by boulder clay of an impermeable nature, and in the Southern counties by clay with flints, that probably the percolation is much smaller. The dry weather flow of its streams being dependent on this percolated water, it would probably not be safe to count on more than two inches of rainfall per square mile, or 80,000 per year gallons per day, as capable of being yielded in wells,* without interfering with the drainage of the country, but a large number of springs might, with great advantage, be utilised, that are now running to waste, which remark applies generally to the springs that are lost in all parts of the country in various geological formations. Many of them occur in railway cuttings and tunnels, where they might easily be collected, and carried by means of pipes along the line to various country stations that the railways pass through. A suggestion of this nature has already been made, I believe, by Mr. Mott, of the Great Western Railway, to his brother Directors; the heavy gradient of many railways would render this on many lines absolutely impossible; but there are many districts where it would be possible, and no difficulty would be met with that could not be passed over by a syphon.

No one scheme or method of water supply can be recommended for the country, for even in one water basin, a gravitation scheme may be best for one portion of the area, and a pumping scheme from wells in another.

Each district requiring special and personal study, it is to be hoped that the Local Government Board may become a department of public health, with a staff of officers ready to give each district individual attention, and rescue them from the ills they now experience.

JOHN EVANS, D.C.L., F.R.S., F.G.S.

I am in receipt of your letter, enclosing copy of a letter from H.R.H. the Prince of Wales, on the subject of national water supply. In reply to your inquiry, I beg leave to express an opinion that, though good might result from the suggested Congress for the discussion of the water supply of this country, yet that there would be great, if not insuperable, difficulties in carrying out any large and comprehensive scheme, such as that indicated by his Royal Highness.

In approaching such a question, it must never be forgotten that the water supply of any given locality is most intimately connected with the geological features of the district, and that the sources of supply which at one place are available and abundant, are at another absolutely unproductive. In some districts, for instance, the whole mass of the country is, up to a certain point, saturated with

* Many chalk wells, in favourable situations, and exceptionable facilities for gathering water, yield supplies of very large volume.

water, which is thus stored in a natural subterranean reservoir, of which the streams appearing on the surface constitute the overflow, and represent the total available amount of water. In such districts the formations which constitute the subsoil are permeable to water, and wells sunk in any position will, on arriving at the subterranean reservoir, meet with a supply of water, the abundance of which will depend upon the permeability of the rock.

In other districts, such as those situated in clay or on the harder rocks, the streams are immediately dependent on the rainfall, and either partially or entirely cease to flow during periods of drought, while any supply from wells is either unattainable or very limited in quantity.

The amount of rainfall which flows off equal areas of country is also extremely variable. Not only does the absolute quantity which falls vary from about 20 inches to even 100 inches per annum, but while upon bare hard rocks nearly the whole of the rainfall is carried off by the surface streams, on some porous rocks, such as chalk, an average quantity of not more than six or eight inches per annum finds its way to a depth of three feet from the surface, the remainder being carried off by evaporation and vegetation. It is, therefore, evident that for the supply of the population in districts of different geological character, different means must be adopted. Where in the summer months the streams run dry and the wells fail, some artificial means of storage are necessary; where, however, the streams are perennial and run over permeable rocks, there exist natural sources of supply and natural storage reservoirs which are always available, though not inexhaustible.

There are, however, other questions connected with the subject besides that of the available sources of supply.

One of these relates to the right which centres of population, whether large or small, have to acquire the water necessary for their use, when by so doing the interests of others are affected. Another relates to the equitable method of meeting the cost of obtaining the supply.

With regard to the first question, it would appear that the principle should be maintained that each town should draw its supply within the watershed on which it is situated, and, only under most exceptional circumstances, be allowed to go beyond it. As to interference with existing rights, the law is fairly clear in the case of streams running above ground; but, with regard to underground waters, and streams running through districts, the subsoil of which is readily permeable, the law, as at present interpreted, operates in the most inequitable manner. Although, if water be pumped directly from a stream, those interested in it are entitled to compensation; yet, if the whole stream were indirectly pumped dry by means of wells placed along its banks, so as to convert the porous bed of the stream into a mere filter, no action would lie for the damage. A legal recognition of rights existing in underground waters, where they follow natural laws as well ascertained as if they flowed above ground, ought certainly to be accorded if law and reason are to go hand in hand, and would turn away some of the opposition now raised to schemes for utilising such waters.

With regard to the incidence of the cost of waterworks, it will usually be found that, in the larger towns, the supply of water will be sufficiently remunerative for it to be undertaken by private enterprise, or by the local authorities, or, at all events, without having recourse to what must be regarded as a charitable rate. But, in the smaller towns, and in country parishes, the conditions are often totally different. The position of nearly all our small towns and villages has been determined by the existence, upon the spot, of a more or less abundant supply of water. In many instances, this is derived from shallow wells, which, owing to the neglect of proper drainage and sanitary precautions, have become dangerously polluted. In such cases, where it is quality rather than quantity which is defective, it is, perhaps, drainage rather than water supply which ought to be studied. In other cases, where from local causes the population has increased beyond the water supply, new sources will have to be sought; and here the question as to who should bear the cost requires careful consideration. If those who built houses in situations where no proper water supply existed were made responsible for obtaining the necessary water, no one could in fairness object; but the system at present pursued of calling upon a district or even a whole parish to be rated for the supply of water to a new colony of houses erected by some building speculator is manifestly unjust. No wonder that those who live, it may be, miles away, though in the same parish, and those against whose will the new houses have been erected, without which the old water supply would have sufficed, object to such claims upon their purse.

The cost, however, of supplying water on a small scale, whether from deep wells or from a distance, is usually so great that it is beyond the resources of a small district to bear it; and if, in the interest of health, such fresh supply is necessary, the area of taxation has to be extended beyond that immediately benefited. When this is the case, the new taxation falls with special unfairness upon those who, at great expense, have provided a proper water supply for their own use, and it presses still more unfairly where, as is the case with water mills and factories possessing a redundant water supply, the basis of the rate is the full annual value, the same as if they were inhabited houses, and not one-fourth of the value, as it is with land, which, in their nature, they more closely resemble.

Such an unfair method of taxation raises objections to the improvement of the water supply in country places, and renders most schemes for the purpose unpopular. In this respect, therefore, the provisions of the existing law also require amendment.

Such are some of the considerations which occur to me in connection with the subject of your letter, and which I have the honour of submitting to you as those upon which I might probably enlarge, should the proposed Congress be held.

E. FRANKLAND, D.C.L., F.R.S., Professor of Chemistry, Royal School of Mines.

I have to thank you for your communication enclosing a letter from his Royal Highness the Prince of Wales, and to say in reply that,

although I am not prepared to suggest any comprehensive scheme of a national character, I should like to attend the Congress, and to take part in its deliberations, if such observations as I have to make should be deemed relevant to the proposed discussion.

The following are the topics which occur to me, at the present moment, as bearing more or less directly upon the subject, and upon which I should be prepared to speak:—

1. The increasing pollution of rivers and streams renders the supply of wholesome water from them more and more difficult.

2. There are two sources of wholesome water in England, viz., upland surface water, and subterranean water. Of these the first is the best for manufacturers, and the second for domestic use.

3. Although I cannot see how a comprehensive scheme of water supply of a national character could be carried out without both waste of capital and interference with manufacturers, I consider that the adoption of a few general principles in legislation would be of great advantage in procuring a fair distribution of water, and preventing needless waste. Thus (*a*): The withholding of permission from towns, &c., to go to a great distance for water until both the before-mentioned sources of wholesome water have been exhausted. (*b*.) Where a distant source is allowed, the securing of a necessary provision for intermediate towns, villages, and hamlets. (*c*.) In large towns, the separate supply of water for manufacturers, street-waterings, and outdoor purposes generally. (*d*.) The sale of domestic water by meter to all houses above a certain rent.

4. The waste of domestic water is a crying evil which can only be efficiently remedied by the compulsory use of meters. In Glasgow, 38 gallons per head are used for domestic purposes; in London, 26 gallons; and in Malvern, where the meter system is in use, 7½ gallons per head. Ten gallons daily per head are amply sufficient for domestic purposes, and would probably never be reached if the water were sold by meter.

5. By separating the in-door from the out-door supply, and selling the former by measure, the quantity of wholesome water required would be reduced to one-third or less, and there would be no risk of unwholesome water being used for dietetic purposes through carelessness or mistake.

RICHARD HASSARD, Mem. Inst. C.E.

INTRODUCTORY.

The question of utilising the great natural resources of the kingdom for the purpose of a water supply of a national character, as suggested by H.R.H. the Prince of Wales—the practicability of which is soon to form the theme of public discussion—has so much in common with a project originating with the author of this paper some fifteen years ago, and brought before the Royal Commission on Water Supply in 1866, in the names of Mr. G. W Hemans and of himself as joint engineers, that he is induced, in compliance with a communication from the Council of the Society of Arts, to reproduce, as it were, the subject-matter of it here, in the hope that its discussion may in some degree assist in the elucidation of a question, the recognised importance of which can scarcely be over-estimated, and with which it is daily becoming more difficult to deal; as probably no subject of late years has attracted a greater share of public attention than that of obtaining pure water for the various towns and populations throughout the kingdom, nor is there one on which the public mind has undergone a greater change. Works for this purpose, the idea of which not many years ago would have been treated with ridicule, are now daily undertaken, and large sums of money are every year spent in seeking Parliamentary sanction for the construction of new or extension of existing waterworks. In the manufacturing districts, every little bit of water-producing moor is strictly guarded, and each large town is jealous of its neighbours. Many of them are now casting about for the means of increasing their existing supplies, and any attempt to encroach on water rights is there looked on with the gravest apprehension.

Past experience has shown that the largest waterworks are eventually the most economical, and that those which have been constructed on the most extensive scale, although it may involve bringing water from a distant locality, have not only been the most successful, but supply water to the consumers at the lowest rate of charge.

The enormous increase in London, during the last 25 years, both of the population and of the consumption of water, coupled with the probability of this increase being maintained, renders it imperative that any new undertaking, embracing the supply of the metropolis, should be of sufficient magnitude, not only to provide for the wants of a community much larger than the present—as it is obvious that before any great project such as treated of in this paper can be carried into effect, the population will have largely increased—but should be capable hereafter of easy extension and expansion, so as to provide for the wants of a vastly larger population, and for a long distant future.

In 1850, the population of London was 2,000,000, and the daily average consumption of water was 44,000,000 gallons. In 1877, the population had increased to 4,000,000, and the consumption had attained to nearly 130,000,000 gallons daily; this will give some idea of the magnitude of the question, and of the difficulties attendant on its successful elucidation.

No doubt much of the present large consumption is due to waste, and might to some extent be rectified by strict supervision and the use of proper fittings for house services; but the author is of opinion that no scheme of national water supply, such as now treated of, should be seriously entertained, unless it were capable of providing immedietely on completion for metropolitan use about 175,000,000 gallons, and for local distribution to towns and localities contiguous to the line of aqueduct about 75,000,000 gallons daily, and, further, that it should be capable of gradual expansion, so as ultimately to supply for general and metropolitan use about 400,000,000 gallons daily.

The question then at once arises—Where can we find a locality or localities from which such an enormous quantity of water, after making compensation to the various interests, can be pro-

cured, and possessing also the means of storing it at such an altitude as to permit of its being easily made available for distribution throughout a great part of England, and to the metropolis. And here it may be remarked, that this question of storage is one of the main difficulties inseparable from any such undertaking; for instance, to illustrate it, to provide 120 days' storage for a supply of 400,000,000 gallons daily would require reservoirs having an aggregate water surface of nearly 9,000 acres, or about 14 square miles, with an average depth of 20 ft.

The author believes that such a result can be attained only by resorting to the elevated lake districts of England and Wales, and by constituting the undertaking, as suggested by the Prince, a national or imperial one, for supplying water, not merely to the metropolis, but to the various provincial towns and populations intervening between London and the sources of supply.

The project now put forward may, therefore, be briefly described as one for impounding the enormous rainfall of the lake districts in natural elevated lakes, and obtaining therefrom a quantity of 400,000,000 gallons daily for distribution throughout a great part of England, and to the metropolis.

In the Lake districts are to be found all the conditions necessary for the successful carrying out of such a gigantic undertaking. The geological formation is nearly altogether Silurian slate, consisting for the most part of bare rock and steep uncultivated mountain, of hopeless sterility, and incapable of cultivation; the localities are nearly devoid of population, and almost free from peat or other sources of discolouration, and produce water of remarkable purity, brilliancy, and softness, perfectly colourless, and containing per imperial gallon not more than four grains of solid constituents, and of these only about half of a grain is of organic matter, and that of a harmless kind; it dees not dissolve lead, and, in short, better water it is impossible to obtain.

Descriptive particulars of the gathering grounds and storage, and generally of the project, beginning with the northern districts.

In the counties of Westmoreland and Cumberland, to the north of Windermere and Kendal, there lies a tract of well known mountain land, rising to considerable elevations, and on which, as is notorious, there falls an extraordinary amount of rain; the portion of the district now immediately in question may be roughly taken as bounded on the north by a line drawn from Penrith to Keswick, and on the south by the watershed of the mountain range north of Windermere and Kendal; it may also be taken roughly as bounded on the west by Borrowdale and the River Derwent, and on the east by the Lancaster and Carlisle Railway between Shap and Penrith, forming, in fact, the eastern and least frequented part of the lake country.

The gathering ground would extend over about 180 square miles, or 115,200 acres, and, if at any time hereafter necessary, water from adjacent localities also can easily be procured.

It has been satisfactorily ascertained that in a series of dry years, a rainfall of 62 inches may be relied on. After deducting the loss by evaporation and for compensation, there would remain 42 inches as available, this would suffice in the driest years for a supply of 299,548,260 gallons daily. As to the capability of the locality no doubt, therefore, can exist.

The district is intersected by three great and deep valleys, running from south to north, at right angles to the prevalent winds, and forming immense troughs for the deposition of rain.

The heads of these valleys also are passes in the mountain chain, open to the south-west, from which quarter the wettest winds blow, and through these open-mouthed funnels the warm aqueous vapour is driven in great volume, to be immediately condensed and precipitated in the valleys on the northern side of the mountains.

In these valleys lie respectively the Lakes of Haweswater, Ullswater, and Thirlmere, proposed to be converted into immense reservoirs, a purpose for which they are admirably adapted, and which can be carried out with but little injury to the scenery or to residential property.

In confirmation it may be stated that Haweswater and Thirlmere are lonely and unfrequented lakes, the best proof of that being that there is no hotel accommodation at or near them, and Ullswater would not be appreciably lowered or affected until after the expiration of a drought much longer than has ever been known to occur in this district of constant rain; of this there is positive and undeniable evidence.

Haweswater occupies the eastern, Ullswater the central, and Thirlmere the western valley, and into these lakes would be collected by artificial watercourses and diversions of streams, the rain falling on portions of the district beyond their natural areas of drainage.

Immediately to the westward of the Wythburn Valley, in which Thirlmere is situate, and not more than four miles distant from it, lies the parallel Valley of Borrowdale, in which the annual rainfall has attained to 244 inches—the average for the last 17 years being 162 inches—and which is well known as the wettest spot in the British Isles.

At the foot of this valley, and only four miles distant from Thirlmere, is Derwentwater Lake, with a water surface of 1,500 acres, from which an immense additional quantity of water can at any future time be obtained, and made available by the simple expedient of pumping it into Thirlmere; and distant but 2½ miles from Derwentwater, and at only 12 feet lower level, is Bassenthwaite Water, with a drainage area of about 60 square miles, and a water surface of 1,200 acres, from which the supply can be still further augmented.

The Lakes of Haweswater, Ullswater, and Thirlmere are at different levels, the central one, Ullswater, being the lowest of the three, its winter level being 477 feet above the Ordnance Datum.

When the lake scheme was brought before the Royal Commission on Water Supply in 1866, it was thought most desirable that Haweswater and Thirlmere should communicate from either side with Ullswater, which would form a great central reservoir, and from which the supply would be drawn off, and this, if deemed best, may still be done; but subsequent reflection has led the author

to believe that a modification of such an arrangement would be attended with advantage. He would therefore propose now that the water from Haweswater and Thirlmere should be drawn off by gravitation, and that from Ullswater lifted by steam power about 50 feet, so as to flow into a small lake called Brothers Water, situate about two miles south of Ullswater; into this lake also would be conducted the water from Haweswater, the water of both lakes would be conveyed by tunnel under Kirkstone Pass, to the south side of the mountain range, where it would unite with the water to be brought from Thirlmere. At this point the main aqueduct would commence at an elevation of about 517 feet above the Ordnance Datum, and be carried past Windermere and Kendal, along the eastern side of Lancashire, to the eastward of Manchester and the Potteries, of the Black Country, and of Birmingham, to London —avoiding on its route all coal fields and mineral workings—and would terminate in a large reservoir, to be constructed on the north side of London, at a distance of about 14 miles from Hyde-park, and at an altitude of 265 feet above the Ordnance Datum. From this reservoir water would be distributed to the existing service reservoirs and works of the different water companies.

The engine-power required at Ullswater would be, including spare power, about 1,350 horse-power for each 100,000,000 gallons daily, being not much more than that provided for lifting a portion of the London sewage at Abbey Mills Pumping Station; the buildings could be ornamental, in harmony with the scenery, and the establishment smokeless, and the cost of pumping would be more than compensated for by the saving in construction consequent on this mode of dealing with the question, and by the additional elevation so gained for the entire supply.

Immediately to the south of the Potteries, the main aqueduct would be joined by the branch conduit from the Bala district, projected for the purpose of recouping to the main aqueduct the water given out to the manufacturing towns and districts north of that locality.

Descriptive particulars of the gathering grounds and storage of the Welsh Districts.

The drainage area to Bala Lake is about 36,000 acres, or 56 square miles; it is in all respects similar to that of the northern lakes, and produces water of equal purity; the lake itself is at an elevation of 530 feet above the Ordnance Datum, has a water surface of 1,150 acres, and its storage can be so arranged that 70,000,000 gallons daily may easily be obtained from it.

About 10 miles distant from Bala Lake, and in a southerly direction, is the River Vyrnwy, one of the upper sources or tributaries of the River Severn; on it exists a site for a very large reservoir, the drainage area available (24,000 acres) being of a similar nature to that of Bala Lake; the water from this reservoir may be united with that from Bala Lake, and the supply of 100,000,000 gallons daily from the Welsh districts so made up—this was one of the reservoirs proposed by Mr. Bateman in his scheme for supplying London from the sources of the River Severn—it would be the only artificial reservoir in the project, and its construction would not be necessary until the capabilities of the lakes were exhausted.

The length of the main aqueduct from Brothers Water lake to the proposed regulating reservoir on the north side of London, would be about 260 miles; those portions of it consisting of conduit and tunnel should be constructed for the full supply of 300,000,000 gallons. A conduit 24 feet wide and 10 feet deep, with a fall of eight inches per mile, would convey rather more than this quantity. The syphon pipes, where valleys are crossed, should have a fall of about two feet per mile, and can be arranged so as each to deliver about 37,500,000 or 500,000,000 gallons or more daily, as may be deemed best, and can be added to from time to time to meet the requirements of increased consumption.

The branch conduit from the Bala District would be about 70 miles in length, and its construction may be arranged in a somewhat similar manner.

In conclusion, the author has to remark that this project has been thoroughly looked into, and all the details of rainfall, drainage areas, and storage, have been carefully studied; even the approximate route which the aqueduct would follow from the lake districts as far as Manchester has been definitely fixed, the contoured six inches to a mile Ordnance Maps of the northern part of England enabling this to be done with great accuracy. He asserts that there is nothing conjectural or chimerical in the proposed undertaking, and that there is no engineering obstacle in the way that has not elsewhere been successfully overcome; that there is no greater difficulty in conveying water from the lake districts to London than there is in conveying water from Thirlmere to Manchester—indeed, the most difficult part of the undertaking is that between Manchester and the lakes; that the cost per individual of the population to be served would not be much more than has elsewhere been expended; and, should further inquiry into this project be deemed desirable, he will be prepared to substantiate his statements. He is further of opinion, should the scheme now before Parliament for the purpose of authorising the Corporation of Manchester to appropriate Thirlmere pass into law, that it would not be unreasonable to ask that clauses should be introduced into that Bill, requiring the Manchester authorities not to proceed with the construction of the undertaking for a limited period, say of two years, until the feasibility and features of the larger scheme have been fairly and fully investigated, and, in the event of the larger scheme being deemed worthy of adoption, that Manchester should then share in the general benefit equally with other towns and localities; there is an abundant supply for all, but it can be made available only by a comprehensive national undertaking, as proposed by H.R.H. the Prince, and as here treated of.

The cost of the undertaking would be:—

For the works of collection and impounding water in the lake districts, and for the main aqueduct to London, &c.	£18,000,000
For the branch aqueduct to Welsh district, and for works connected therewith	2,500,000
	£20,500,000

Say £21,000,000 = £52,500 per 1,000,000 gallons daily.

The populations of the different towns and localities, including the metropolis, to whom water might be supplied, number about 8,000,000, and the cost would consequently be at the rate of about £2 12s. 6d. per individual. In this respect, therefore, as well as in the cost per million gallons daily, the project would compare favourably with any large waterworks hitherto constructed.

CONVERSAZIONE.

The Society's *Conversazione* was held at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday last, the 19th June.

The galleries containing the Raphael Cartoons, the Sheepshanks' Collection, the William Smith Collection of water-colour drawings, the Dyce and Forster Pictures, the Collections of Paintings lent by Mr. Fuller Maitland and Lord Spencer, and the Schliemann Collection of objects from Troy were open, as well as the courts and corridors of the ground floors. The reception was held in the throne room of Akbar Khan in the Architectural Court, by Mr. WILLIAM HAWES, F.G.S., Deputy-Chairman, assisted by the following Vice-Presidents and Members of the Council:—Mr. G. C. T. Bartley, Mr. R. Brudenell Carter, Mr. A. Cassels, Mr. E. Chadwick, C.B., Mr. Hyde Clarke, Mr. Henry Doulton, Mr. C. J. Freake, Sir U. J. Kay-Shuttleworth, Bart., M.P., Mr. W. H. Perkin, F.R.S., and Mr. Robert Rawlinson, C.B.

A Promenade Concert was given by the Band of the Royal Marines (Conductor—Mr. Kappey), in the North Court, the following being the programme of the music performed:—

March	"Schwarze Peter"	Suppé
Overture	"La Dame Blanche"	Boieldieu.
Selection	"Fledermaus"	Strauss.
Valse	"Träume auf dem Ocean"	Gung'l.
Fantasia	"Don Juan"	Mozart.
Overture	On Melodies by Schubert	Suppé.
Gavotte	"Stella"	Kappey.
Valse	"O schöner Mai"	Strauss.
Selection	"The Bohemian Girl"	Balfe.
March	from "Suite, Op. 113"	Lachner.
Selection	"Faust"	Gounod.
Overture	"Rosamunde"	Schubert.

A Promenade Concert was also given by the band of the Coldstream Guards, in the South Court (Conductor—Mr. Fred. Godfrey), the following being the programme:—

Overture	"Tancredi"	Rossini.
Valse	"Mon Rêve"	Waldteufel.
Serenade		Schubert.
Cornet Solo, Mr. Cody.		
Selection	"Stradella"	Flotow.
Austrian Hymn, "God Preserve the Emperor,"		Haydn.
Arranged, with Variations, from the celebrated Quartette.		
Fantasia	"The Sorcerer"	A. Sullivan.
With Solos for the Principal Performers.		
Piccolo Solo, with Variations		J. H. Young.
Mr. Nice.		
Reminiscences of Wales		Fred. Godfrey.
Introducing Welsh national songs and dances, with solos for clarionet, Mr. Hancock; cornet, Mr. Cody; euphonium, Mr. Darnley; flute, Mr. Pougher; bassoon, Mr. Langdale; petit clarionet, Mr. Davis; piccolo, Mr. Nice.		
(Published for the pianoforte by Chappell and Co., New Bond-street.)		
Selection	"Les Cloches de Corneville"	Planquette.
With solos for the principal performers.		
Potpourri	German Melodies	Hartmann.
Glee	"The Chough and Crow"	Sir H. R. Bishop.
(By desire.)		
Galop	"Champagne"	Lambye.

A Vocal Concert, consisting of glees, was given at intervals during the evening, in the Lecture Theatre, by the London Glee and Madrigal Union, Madame Clara Suter, Miss Marion Severn, Mr. Large, Mr. H. Taylor, Mr. F. Cozens, and Mr. Lewis Thomas, under the direction of Mr. Lawler. The glees sung were as follows:—

From 9 to 9.30.		
Quintett	"Now by day's retiring lamp"	Sir H. R. Bishop.
Glee	"When the wind blows in the sweet rose tree"	W. Horsley, M.B.
Glee	"Strike the lyre"	T. Cook.
Trio	"Hark the Curfew's solemn sound"	T. Attwood.
Four-part Song	"When evening's twilight"	J. L. Hatton.
Glee	"Who is Sylvia?"	Ravenscroft and Morley.
From 9.45 to 10.15.		
Glee	"Come o'er the brook, Bessie, to me,"	Ford and Dr. Calcott.
Glee	"I wish to tune my quivering lyre"	Walmisley.
Four-part Song	"Breathe not of parting"	
(Arranged by H. Leslie) melody by Mendelssohn.		
Quintet	"Believe me, tears"	Sir H. R. Bishop.
Madrigal	"Down in a flowery vale"	C. Festa, 1541.
From 10.30 to 10.50.		
Quintet	"Blow, gentle gales"	Sir. H. R. Bishop.
(Operetta of "The Slave.")		
Serenade	"In this hour of softened splendour"	Ciro Pinsuti.
Four-part Song	"The Three Chafers"	Trubn.
Serenade	"Sleep, gentle lady"	Sir H. R. Bishop.
Madrigal	"Oh, by rivers"	Dr. Wilson and F. Saville, 1667.

The number of visitors attending the *Conversazione* was 2,505.

MISCELLANEOUS.

INDUSTRIAL ART AT VENICE.

Consul Smallwood states that in a commercial point of view, both industrial art and the fine arts have obtained a development which enables Venice to take rank with Naples and Milan. Rome and Florence are both in decadence, and art seems to have fled her ancient abodes for cities where schools and the facility for study are abundant. The largest exportations from Venice of modern paintings are for Great Britain, but at the time

this notice was written upwards of a score of distinguished painters were preparing for the Paris Exhibition.

Many foreign artists are residents: the unequalled advantage of this city in its variety of scenic attraction has made it a mart for the school of Canaletti. The peculiar transparency of light in the lagoons lends a refining influence to colour, whilst experienced hands are known to avail themselves in spring and autumn of the effect of the setting sun, when for a few brief hours it lightens up the treasures of the inmost recesses of the Duomo and other edifices.

There is also now a great demand for artistic imitations in bronze from ancient models: in this branch of art Michieli is well known in England. A recent discovery for casting in bronze without modelling in wax or the need of after polishing, by Giordani, an experienced hand, promises a new era of despatch and perfection in bronzes. Wood carving, in imitation of the antique, has received a great impulse from the appreciation in England of Venetian handicraft. Many students of sculpture are now practising in this art from the encouragement received. Under the direction of the eminent sculptor, Luigi Ferrari, whose triumph in the group of the "Laocoon" at Milan, raised him to supremacy at the Royal Academy, twenty sculptors of avowed merit have obtained patronage of fame.

Although it is admitted that within the last ten years English competitive talent shares to a considerable extent the commercial profits, yet the incessant revelation of newly-discovered art treasures, and the ever-increasing demand for superior talent, continue unabated.

When it is considered that a hundred artists of eminence are employed in this city, mostly upon commission works for Great Britain, it may be looked upon as an important article of exportation, and the increasing demand for illustrations of Venetian archæology and scenery form no insignificant item and proportion of the produce of a city scarcely numbering 130,000 citizens, hundreds of whom may be supposed to derive a livelihood from the master hands of their craft in the industrial department of the arts. An agency is about to be established in London under the auspices of an experienced Venetian artist, enjoying the confidence of the *élite* of the craft, in order to treat for the supply of amateurs.

CORRESPONDENCE.

STRAW AS PAPER MATERIAL.

In the *Journal* for June 7th, there is a paragraph at page 692, upon which I wish to observe that there is no paper-mill in England using 200 tons of straw weekly, or even half that quantity; nor is it clear in what respect a mill using straw has so considerable an advantage over one using it as to reap an important extra profit upon the paper made therefrom. If straw, costing £2 10s. (it costs more) per ton, is cheaper than esparto or rags, so is the product of the first cheaper than that of the two last-named materials. Straw is not a good paper fibre, and, as a matter of fact, very little straw-paper is now manufacted in Great Britain. T. F. Boyd.

68, Upper Thames-street, London.
June 19, 1878.

GENERAL NOTES.

British Association.—The usual invitation circular has been issued for the forty-eighth meeting of the British Association, which will be held at Dublin, commencing Wednesday, 14th August, under the presidency of Mr. William Spottiswoode, LL.D., F.R.S., &c. The General Committee will meet on Wednesday, the 14th of August, at 1 p.m., for the election of sectional officers, and the despatch of business usually brought before that body. On this occasion there will be presented the report of the Council, embodying their proceedings during the past year. The General Committee will meet again on Monday, August 19th, at 3 p.m., for the purpose of appointing officers for 1879, and of deciding on the places of meeting in 1879 and 1880. The concluding meeting of this committee will be held on Wednesday, August 21st, at 1 p.m., when the report of the Committee of Recommendations will be received. The first general meeting will be held on Wednesday, the 14th of August, at 8 p.m., when the President will deliver an address; the concluding meeting on Wednesday, the 21st of August, at 2.30 p.m., when the Association will be adjourned to its next place of meeting. At two evening meetings, which will take place at 8.30 p.m., discourses on certain branches of science will be delivered. There will also be other evening meetings, at which opportunity will be afforded for general conversation among the members. The sections are:—A. Mathematical and Physical Science; B. Chemical Science; C. Geology; D. Biology; E. Geography; F. Economic Science and Statistics; G. Mechanical Science. Organising Committees are constituted for the purpose of obtaining information upon the memoirs and reports likely to be submitted to the sections, and of preparing reports thereon, and on the order in which it is desirable that they should be read, to be presented to the committees of the sections at their first meeting. The Organising Committees meet on the first Wednesday of the annual meeting at 11 a.m., to settle the terms of their report. The different sections will assemble in the rooms appointed for them for the reading and discussion of reports and other communications, on Thursday, August 15, Friday, August 16, Saturday, August 17, Monday, August 19, and Tuesday, August 20, at 11 a.m, precisely.

Battery.—A new form of battery has recently been patented by General Franzini, of the Italian army. In it a number of guns are mounted on a single carriage which is protected by a moveable shield. It is claimed that this arrangement would do away with the necessity for erecting works on the field, and would supersede many existing forms of battery.

MEETINGS FOR THE ENSUING WEEK.

Mon.....Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. W. T. Thistleton Dyer, "Plant Distribution as a Field for Geographical Research."

Tues....Women's Protection League (at the House of the Society of Arts), 8 p.m.
Statistical, Somerset-house-terrace, Strand, W.C., 3 p.m. Annual Meeting.
Anthropological Institute, 4, St. Martin's-place, W.C., 1. Rev. S. J. Whitmer, "Ethnology of the Islands of the Pacific" 2. Mr. Worthington G. Smith, "Palæolithic Implements from the Gravels of N. E. London." 3. Mr. A. L. Lewis, "Remarks on some Archaic Structures in Dorsetshire and Somersetshire." 4. Mr. G. M. Atkinson, "A New Method of Finding the Cephalic Index."

Wed....**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 4 p.m. Annual General Meeting.
Society of Public Analysts, 79, Great Tower-street, E C. 1. Mr. A. Winter Blyth and Mr. W. C. Young, "The Detection of Alum in Flour." 2. Mr. A. H. Allen, "The Assay of Carbolic Acid Powders." 3. Dr. Dupré, "Note on the Detection of Alum in Flour." 4. Mr. G. W. Wigner, "Preliminary Notes on the Nitrogen Salts contained in the Cereals." The Report of the Council in connection with the recent correspondence as to the reference of disputed samples to Somerset-house will be again brought forward.
East India Association, 20, Great George-street, Westminster, S.W., 3 p.m. Mr. George Foggo, "The Employment of Indian Troops in Europe."

Thur....Antiquaries, Burlington-house, W., 8½ p.m.
Royal Society's Club, Willis's-rooms, St. James's, 6.30. p.m. Annual Meeting.

Fri......Charity Organisation (at the House of the Society of Arts), 8 p.m. Captain J. L. Needham, "Lessons from the Late War."
Archæological Institution, 16, New Burlington-street, W., 4 p.m.
Quekett Microscopical Club, University College, W.C., 8 p.m. Mr. Frank Crisp, "The Influence of Diffraction in Microscopic Vision"
Royal Botanic, Inner Circle, Regent's-park, N.W., 4 p.m. Prof. Bently, "The Classification, Properties, and Uses of Plants." (Lecture VIII.)

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,336. Vol. XXVI.

FRIDAY, JUNE 28, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

PARIS EXHIBITION—ARTISANS' REPORTS.

An adjourned meeting of the members of the Bristol Chamber of Commerce and of manufacturers interested in the subject was held on the 21st inst., for the purpose of considering the subject of sending skilled artisans from Bristol to report on the Paris Exhibition. Mr. G. de Lisle Bush presided, and there were present Messrs. H. T. Chamberlain, W. M. Gibson, C. B. Hare, H. Taylor, C. F. Hare. J. Evans, S. Tanner, W. Lane, A. R. Grace, C. E. Gardner, E. Robinson, W. Polglase, A. M. Edwards, L. Bruton, E. Waterman, G. K. Stothert, W. Hunter, R. Brightman, U. Alsop, T. Francis, F. G. Tyler, &c. Considerable discussion on the question took place, and eventually the matter was referred to a special committee, composed of Messrs. G. de Lisle Bush, H. T. Chamberlain, C. B. Hare, U. Alsop, E. Waterman, H. Taylor, J. Evans, W. Polglase, E. Robinson, T. Francis, G. K. Stothert, and S. Tanner, with power to add to their number.

The proceedings then terminated. Subscriptions to the amount of sixty guineas were promised in the room.

ANNUAL GENERAL MEETING.

The Annual General Meeting, for receiving the report from the Council, and the Treasurers' Statement of Receipts, Payment, and Expenditure during the past year, and also for the Election of Officers, was held, in accordance with the Byelaws, on Wednesday last, the 26th June, at four p.m., Mr. W. Hawes, F.G.S., Deputy-Chairman of the Council, in the chair.

The **Secretary** read the notice convening the meeting, and also the minutes of the previous annual meeting.

On the motion for confirming the minutes,

Mr. Ford objected that they were not complete, inasmuch as he had moved a resolution to the effect that the reading-room should be kept open in the evening, no notice of which appeared on the minutes.

The **Secretary** said if any motion were made it ought to have been recorded; he would have the notes taken at the time referred to.

Mr. Ford said he certainly moved, and he believed the motion was seconded and put to the meeting, He would take the opportunity of bringing the subject forward again.

Mr. F. W. Campin recollected the matter referred to being mooted, but did not remember whether it was carried.

The **Chairman** suggested that, as by the bye-laws the ballot had to remain open one hour, it would be convenient if he were to declare the ballot open at once, which would not interfere with the question raised on the minutes being settled.

This being acceded to, the Chairman nominated Admiral Sir Erasmus Ommanney and Mr. Cooke scrutineers, and declared the ballot open.

Mr. Ford began some remarks on the subject of the election of officers of the Society, but

The **Chairman** informed him that he was out of order, the next business being the reading of the report of the Council.

Mr. Ford said he would simply ask members not to tender their ballot papers until he had had an opportunity of making some remarks.

The **Secretary** then read the following:—

REPORT.

In compliance with the Bye-laws, the Council lay before the members their report of the proceedings of the Session just concluded.

The Council congratulate the Society on its continued prosperity. During the last Session the Society has been actively, and it is hoped usefully, engaged in a variety of subjects connected with the progress of Arts, Manufactures, and Commerce.

National Water Supply.

Early in the session the Council received from H.R.H. the President the following letter:—

Clarence-house, St. James's, S.W.,
30th January, 1878.

Sir,—The supply of pure water to the population is at the present time exciting deep interest throughout the country. Our great cities and populous towns, such as Manchester, Liverpool, Birmingham, and others, are, each for itself, taking steps to obtain an improved and increased supply, whilst the metropolis is seeking further powers from the Legislature with the same object in view. The smaller towns and villages are dependent on accidental sources of supply, and in many instances these are wholly inadequate for health and comfort. While the larger populations are striving, each independently and at enormous cost, to secure for themselves this article of prime necessity, the smaller localities must make the best shift they can, and in many instances are all but without any supply at all.

Under these circumstances, I would draw the attention of the Council to the subject, and suggest whether, at the present time, great public good would not arise from an open discussion on the question in the Society's rooms, with a view to the consideration of how far the great natural resources of the kingdom might, by some large and comprehensive scheme of a national character, adapted to the varying specialities and wants of districts, be turned to account, for the benefit, not merely of a few large centres of population, but for the advantage of the general body of the nation at large.—I have the honour to be, Sir, yours faithfully,

(Signed) Albert Edward P.,
President of the Society of Arts.

To the Chairman of the Council
of the Society of Arts.

The Council, impressed with the great importance of the subject to which H.R.H. had thus drawn their attention, determined to convene a Congress, and to invite the attendance of persons specially interested, either by profession or otherwise, and qualified to express their views. Accordingly a Congress was assembled on the 21st and 22nd May, well attended by representatives from all parts of the Kingdom, urban and rural sanitary authorities, and others. The discussion lasted two days, and was taken on the following heads:—

1. The Great Natural Water Resources of the Kingdom.

2. How they can best be utilised and economised for the supply of—

  a. Large Towns, Small Towns, and Country Places.

  b. London.

Papers were prepared by a number of gentlemen on the various branches of the subject, and were brought before the meeting. Much interest was displayed, and it was admitted on all hands that the water supply of the kingdom was worthy the deepest attention of all interested in the welfare and health of the population, and the following resolution was passed unanimously, as well as one thanking H.R.H. the President, for his thoughtful and suggestive letter:—

"That this Congress desires to urge upon her Majesty's Government the importance of taking steps, with the least possible delay, to appoint a small permanent Commission, to investigate and collect facts connected with water supply in the various districts throughout the United Kingdom, in order to facilitate the utilisation of the national sources of water supply, for the benefit of the country as a whole, as suggested by his Royal Highness the Prince of Wales, the President of the Society of Arts, and recommends that the Council of the Society be requested to ask the Earl of Beaconsfield to receive a deputation to present the resolution and advocate its adoption."

A full report of the Papers and Discussions of the Congress is in course of publication in the Society's *Journal*, and will appear in a separate pamphlet very shortly.

As a very large mass of valuable information on the subject of water supply already exists buried in reports of committees, commissions, and other publications, but which, in the form of Blue-books, is either not readily accessible to the public, or is mixed up with other matter, the Council have thought it would be of value if a digest of such portion of these works as relate to water supply were made, together with a list of works in which information of this character is to be found, and accordingly they have had such a digest made, and the same will soon be ready for issue, in a small volume, at a price of 3s. 6d.

Health and Sewage of Towns.

The third annual Conference on this subject was held on the 23rd and 24th May, under the presidency of the Right Hon. James Stansfeld, M.P. It was well attended by representatives from various parts of the kingdom. Papers were read and discussion taken on the following heads:—

1st. Gradual Abolition of Cesspools and Middens, and Substitution of Tubs and Pails with speedy removal.

2nd. Progress, if any, made in Treating Water-carried Sewage since the last Congress.

3rd. Escape of Sewage Gas into Dwellings, and Modes of Prevention.

4th. Progress, if any, made in the Utilisation of Excreta since the last Conference.

5th. Discharge of Sewage into Sea.

6th. Cost of Systems given in the last Report of the Local Government Board.

7th. Whether any further Legislation, of a Compulsory or Permissive Character, is needed for bringing about a better Sanitary Condition of Towns or Dwellings, or any Change in Imperial Administration.

Although no very marked progress can be reported as to the treatment of sewage, a great deal of interest was displayed, and an animated discussion took place especially on the 7th head. The following resolutions were passed unanimously:—

I.—"That this Conference desires to record its opinion that further legislation is needed, especially with regard to the constitution of County Boards, with a view to strengthening the local government administration; and authorises its Chairman, in conjunction with the Council of this Society, to bring the matter before her Majesty's Government in such manner as he and the Council may deem to be most expedient."

II.—"That in the opinion of this Conference, the benefit to large towns of a well-devised and effective system of sewers is very often entirely neutralised by the careless and improper way in which the house drains in connection with such sewers are laid, and connected with the soil and waste pipes of the house."

III.—"That all drains intended to be connected with the sewers of a sanitary authority ought to be made by such authority (in the same way that house services are made by gas and water companies to their mains)."

IV.—"That powers as extensive as those contained in the 11 and 12 Vic., cap. 112, with corresponding duties, should be conferred and imposed upon all local sanitary authorities, including those in the Metropolis."

V.—"That the Society of Arts be requested to urge these views upon the President of the Local Government Board, by deputation or otherwise."

These proceedings are also in course of publication in the *Journal*, and will appear in a collected form in a separate pamphlet.

Congress on the Teaching Domestic Economy in Elementary Schools.

Last year it will be remembered that a most successful Congress was held under the direction of this Society at Birmingham. It was opened with a *conversazione*, and on the two following days papers on different branches of the subject were read, followed by discussions before crowded audiences.

This year a second Congress will be held, taking place at Manchester, over which the Duke of Westminster will preside. The opening takes place this evening with a *conversazione*, and the two following days will be devoted to the reading of the papers and the discussion thereon. The Bishop of the Diocese presides over one of the Committees, and the Ladies Committee has for its President the Countess of Derby. The Mayor and Corporation have given every assistance in their power to make the Congress a success, and have placed the Town-hall and its various rooms at the disposal of the Congress for its meetings. The Duke of Sutherland throws open Trentham and its gardens for the members of the Congress on Saturday.

Memorial Window in St. Paul's Cathedral.

It will be in the recollection of the members that, shortly after the public thanksgiving at St. Paul's Cathedral for the restoration to health of his Royal Highness the Prince of Wales, a proposition was made for a subscription among the members for the erection of a memorial window in the cathedral, commemorative of the event. The North Transept Window was placed at the disposal of the Society for the purpose, and a subscription list was commenced, but before it had proceeded far, a check was given to the movement, and all proceedings were stopped, by reason of difficulties in connection with the operations of the Decoration Committee, who could give no positive reply as to acceptance of the Society's design until the general decoration of the cathedral was settled, it being necessarily a condition that whatever design for the window was adopted it must be in harmony with the decoration of the rest of the cathedral. Year after year passed away in this uncertainty, but it is understood now that the decoration will be forthwith proceeded with, and the Society's design is under consideration of a small committee, and it is expected that the matter will be shortly settled. It is understood that the south transept window will be taken as more suitable for the purpose In this case the subscription, which at the time of the check had only amounted to £349 5s. 6d., will be renewed, and it is hoped that the members will now, when again called upon, respond adequately to secure a work of art which shall be a credit to English talent, and a historic monument of the national gratitude for the recovery of his Royal Highness from his bed of sickness. About £700 is needed.

National Training School for Music.

The members will be glad to learn that this school continues to flourish, though the number of scholarships founded is still below the number which so valuable an Institution ought to command.

The reports of the distinguished Principal and Professors show how much good work is being done, and how well the scholars profit by the instruction there brought home to them. It must be borne in mind that the great and sole object of the institution, and the principle on which it is founded, is to afford instruction for the cultivation and promotion of musical talent wherever it may be found. The members are invited to visit the school at Kensington-gore, and judge for themselves the valuable work which is being carried on there. At present there are but 87 scholars, the numbers being thus limited, from the pecuniary means at the disposal of the school. It is earnestly hoped that members will interest themselves in this truly national work, and promote to all the extent in their power the prosperity of the school, so that it may ultimately become that which it promises to be, a really national institution, worthy of the Nation and of the Society of Arts, its founder.

Evening Meetings.

The Wednesday evening meetings have been highly successful, and in point of subjects of novelty greatly favoured. The Telephone and the Phonograph, the two great marvels of science, have been each illustrated. As regards the Telephone, the Society had the good fortune to have it brought before them by Professor Alexander Graham Bell, the inventor, and so great was the desire manifested to hear the exposition of this extraordinary instrument from that gentleman's own lips, that the great room of the Society was filled to overflowing, and so many were unable to get in that a request was made to Professor Bell to repeat his exposition, a request to which that gentleman most gracefully consented. Accordingly, in order to accommodate the large numbers who, it was known, desired to attend, the large Hall at the "Freemasons' Tavern" was secured. Even that, however, was not large enough to accommodate all who desired to be present. The public thanks of the Society are due to Professor Bell for the kindness which prompted him to meet the wishes of the members.

The Phonograph was well explained to the meeting by Mr. W. H. Preece, and if in this instance the meeting had not the benefit of the presence of its distinguished inventor, Mr. Edison, those present may be congratulated in having had before them so eloquent an exponent of the instrument as Mr. Preece.

But, while giving special prominence to the two foregoing subjects as being the latest and most astonishing developments of science, the Council desire to express their high commendation of the quality and valuable character of the other papers read at the Wednesday evening meetings. In no session have their merits been surpassed. A lengthened detail of these papers is unnecessary.

Indian Section.

The proceedings of this Section have been marked by unflagging interest.

Sir Joseph Fayrer's paper "On the Destruction of Life by Wild Animals and Venomous Snakes in India;" gave most interesting, but startling, accounts of the deaths arising from these causes, amounting to an average of 20,000 human beings, and 50,000 head of cattle annually, and of the impediment caused thereby to traffic and cultivation.

"Irrigation Regarded as a Preventive of Indian Famines;" by Mr. W. T. Thornton, C.B., was a valuable supplement to the paper on "Indian Irrigation," by the same author, in the Session of 1876, when the subject was treated with some special reference to the question of remunerativeness, but now as to its bearing on the prevention of future famines, on which Mr. Thornton took a less sanguine view than some of its well-known advocates. The discussion was a very animated one, and was prolonged to an adjournment.

"Settlement and Military Colonisation of the Hill Districts of India," by Lieut.-Gen. McMurdo, C.B., gave highly interesting information in continuation of the Society's papers on this highly important subject, from actual experience of the productiveness of certain hill districts, and their suitableness as to climate for European settlers; and a practical scheme was suggested for offering facilities to discharged soldiers, of suitable character and qualifications, to become settlers through existing regimental organisation.

Colonel Smith's paper on "The Depreciation of the Value of Silver, with Special Reference to

Exchange between England and India; and Suggestions for a Remedy," entered very fully into this question. It will be remembered that this subject was elaborately treated and discussed in the Session of 1876, when it was taken up by Mr. Ernest Seyd. It seems, however, to have lost little of its interest or importance at the present time, and Colonel Smith's treatment of it was from an entirely original and different, though strictly practical, point of view. The subsequent discussion showed that the subject was well worth putting on the list of papers again.

"The Telegraph Routes between England and India," by Major Bateman-Champain, R.E., Superintendent of Indian Telegraphs, was a concise, but well nigh complete as well as instructive, history of the establishment of our telegraphic communications from the first attempts in 1855 to the present time; and such authorities as Sir James Anderson and Dr. Siemens took the leading part in the subsequent discussion.

"Agriculture in India" was treated by Mr. F. C. Danvers, of the India-office, from mostly a practical point of view, showing how largely production might be increased in India by improved agriculture, and how possible improvement was in many respects. It was illustrated with specimens of actual native ploughs, and with drawings, lent by Messrs. Ransome and Co., of ploughs which had been proved capable of being profitably worked in India by the ordinary native bullocks. Mr. James Caird, C.B., who is appointed member of a Commission about to sit in India to report on this subject, presided.

The meetings were well attended, and the Society may be congratulated on the very successful character of its proceedings in this direction.

African Section.

Six meetings have been held for the consideration and discussion of papers in this Section between the months of January and May. A paper was read by Mr. F. B. Fynney, of the Colonial Service in Natal, on the probable influence of the annexation of the Transvaal upon the progress of civilisation in the interior of Africa, in which the author gave an excellent account of the character of the Zulu Kaffirs, and of their supreme chief, Cetywayo, drawn from his own personal experience, and described very fully the agricultural, pastural, and mineral capacities of the district. Mr. Basil H. Cooper contributed some valuable notes on the monumental obelisks of Egypt, and at the meeting at which these were considered, Mr. Dixon gave an exceedingly interesting account of his plans for the removal of Cleopatra's Needle from Alexandria, and its erection on the Thames Embankment in London. At this meeting Mr. Dixon's communication was illustrated by models of the vessel in which the obelisk was conveyed over the sea, of the machinery and apparatus proposed to be used in the erection, and of the obelisk, with the supporting sphinxes, as they are intended to stand upon the embankment. Mr. B. Francis Cobb communicated a thoughtful and suggestive paper on the commercial changes and aspects of Egypt, in which he insisted upon the fertility and prolific capacities of the country, and urged a more economical application of the public revenues of the State, under a joint protectorate of England and France, as the measure which alone is needed to secure a very large measure of prosperity. In this paper a generous and laudatory allusion was made to the Khedive's efforts to abolish slavery from his dominions.

Dr. Sutherland, the Surveyor-General of Natal, furnished an excellent paper regarding the progress of agriculture and stock farming in that colony, in which he very strenuously urged the importance of winter feeding, manuring, and irrigation for the development of the natural resources of the place. In connection with this paper, Dr. Mann contributed some notes regarding the history of commercial progress in Natal, and drew attention to Mr. J. A. Froude's views as to the proper position of the colonies in reference to the parent empire. Mr. Froude occupied the chair upon the occasion, and bore testimony to the excellence of the climate. He also advocated a system of industrial apprenticeship of the natives of the district. Mr. E. Hutchinson, of the Church Missionary Society, stated his views of the past, present, and future of the Niger, and urged the establishment of patrol steamers upon the river of a character adapted to its traffic, with various other practical measures calculated to forward commercial intercourse with the native tribes. At the last meeting of the Section, Mr. H. B. Cotterill gave an account of his recent sojourn upon Lake Nyassa, with his views of the proceedings required to extinguish the slave trade of Central Africa, and to open out trade with the country surrounding the Nyassa. In the interesting discussion which followed this communication, it was suggested that the Council of the Society of Arts should offer a premium for the utilisation of elephants, for purposes of transport and travel in Central Africa. This is under the consideration of the Council.

Chemical Section.

During the last year there have been but few striking triumphs of chemical science to chronicle; it has been the turn of physical science, in which several remarkable discoveries have been made. Early in the Session the announcement was made from Geneva, and also from Paris, that some of the most refractory gases had at length, by means of cold and pressure, been reduced to the liquid condition; and this may be regarded as an important result of an investigation in physico-chemical science.

The Chemical Section commenced its work this Session with a paper by Mr. A. H. Allen, on "Some Improvements in the Production of Nickel." The discovery of some deposit of a nickel ore in New Caledonia of a very pure character, is likely to have an important influence in the production of this useful metal. The mineral in question is a silicate of nickel and magnesium, and contains about 20 per cent of nickel. Mr. Allen has been engaged in experiments with a view to improve the methods of extraction, and thereby to reduce the cost of production. The number of applications for which nickel is extremely well suited renders it probable that, if it is obtainable at a moderate rate, its use will increase.

Mr. Kingzett has again contributed a paper to this Section, the subject being "The Germ Theory of Disease from a Chemical Point of View." Mr.

Kingzett dissents from some of the points involved in the general doctrines of the germ theory, and contends that the chemical side of the question, set forth by the late Baron Liebig, has not received due attention. The paper gave rise to a useful discussion.

The future of the electric light, especially in view of its replacing ordinary illuminating agents, was brought forward by Dr. Paget Higgs, who has had considerable experience in the recent development of the Siemens dynamo-electric machine. Amongst those interested in present systems of illumination, especially lighting by coal gas, the subject never fails to attract attention. Dr. Higgs is sanguine as to the development of the electric light, and although at present it is certainly not in a position to contend generally with gas-lighting, the improvements effected during the last year or two are not without their significance.

Mr. Gustav Bischof contributed a paper upon the purification of water by filtration, in the course of which he described the various filters used for domestic purposes, with their respective merits and defects. Mr. Bischof suggests that special filtering arrangements, in addition to the ordinary filtration through sand, should be adopted by the several water companies in times of flood or epidemic disease.

Mr. J. Mactear favoured the Section with some of the results of his experience in the manufacture of alkali; this experience has been so large, and Mr. Mactear's name is associated with so many improvements in the various processes, that he speaks with considerable authority. The paper dealt with the whole of the processes generally in operation in an alkali works, from the burning of the pyrites to the utilisation of the waste products. Mr. Mactear has devised a very perfect system of testing, in which the loss of oil of vitriol is daily represented as so much loss per 100 parts of sulphur bought or burned; this result is recorded in a diagrammatic form, which is found to be a very good method for bringing the fact home to the ordinary foreman or workman. The revolving furnaces designed by Mr. Mactear are found in practice to give exceedingly good results; and the same gentleman's processes for the recovery of the sulphur from the noxious waste are amongst the most successful of any devised for the purpose.

The figures representing the growth of the alkali trade stated by Mr. Mactear are remarkable. In 1862, 203,000 tons of alkali were produced, with an employed capital of £2,000,000; in 1876, the production was 430,000 tons, with a capital of £7,000,000. This trade, in common with others, is feeling the present commercial depression, and the figures for the present year are hardly likely to show the usual increase.

The last paper of the present Session was a contribution by Mr. J. M. Thomson, upon the subject of the position which chemistry should occupy in a system of technical education. At the present time, when a scheme of technical education is about to be practically adopted, the nature of the chemical teaching which it is proposed to give is of great importance. There is no science the application of which in Arts and Manufactures is so wide and diverse, for there is hardly a single article of daily use which in some stage of its production has not undergone some chemical change. Mr. Thomson considers that the teaching of chemistry in any technical establishment should be very much on the present lines of such teaching elsewhere, and that it would be unwise to attempt to teach practically, at least at first, the application of the science in manufacturing operations. In other words, it will be best to commence such instruction with the consideration of the elements of chemical science. Again, Mr. Thomson considers that it will be a difficult matter to ensure that those to whom such advantages would be of most value shall receive them, although upon this will largely depend the eventual success of any technical school.

Cantor Lectures.

The first course of Cantor Lectures was by Mr. W. Arnot, on the "Technology of the Paper Trade." These were specially intended for the benefit of students at the Technological Examinations of the Society. Mr. Arnot's lectures gave a full account of the most recent processes of the manufacture, and were highly valued by the members of the trade, who attended and heard them, or read them in the *Journal*. The next course was by Mr. T. Bolas, "On the Use of Photography for Producing Printing Surfaces," &c. These lectures attracted large and interested audiences; they were most ably illustrated, and will, when published in the *Journal*, form a valuable addition to the literature of this subject. In the third course, "On the Preservation of Food," Dr. Richardson gave the results of a very valuable series of experimental researches on putrefactive changes. Though Dr. Richardson has not yet arrived at any result capable of taking a commercial form, he may be said to have cleared the ground for all further experimenters in this direction, and to have laid a basis on which all such practical work must of necessity hereafter be based.

Additional Lectures.

Besides the Cantor Lectures, a very valuable and interesting course of additional lectures was given by Mr. Thos. Wills, F.C.S., on "Explosions in Coal Mines." In these special reference was made to the dangers attending the use of so-called safety lamps, and also to the effect of coal dust in the atmosphere of mines, as a source of danger hardly yet sufficiently recognised. These and many other points were carefully and elaborately dealt with, and these lectures present a very useful and complete summary of this important question.

Medals.

The Albert Medal for "distinguished merit in promoting Arts, Manufactures, or Commerce" has this year been awarded, with the approval of H.R.H. the Prince of Wales, the President of the Society, to—

Sir Wm. G. Armstrong, C.B., F.R.S., D.C.L., "because of his distinction as an engineer and as a scientific man, and because by the development of the transmission of power—hydraulically—due to his constant efforts, extending over many years, the manufactures of this country have been greatly aided, and mechanical power most beneficially substituted for most laborious and injurious manual labour."

Medals for papers read at the evening meetings of the Society have been adjudged as follows:—

Alexander Graham Bell, for his paper on "The Telephone."
J. Bennett Lawes, F.R.S., for his paper on "Freedom in the Growth and Sale of the Crops of the Farm, considered in its Bearings upon the Interests of Landowners and Tenant Farmers."
W. H. Preece, for his paper on "The Phonograph, or Talking Machine."
R. M. Gover, M.R.C.P., for his paper on "Dietaries, in their Physiological, Practical, and Economic Aspects."
Basil H. Cooper, B.A., for his paper on "Egyptian Obelisks and their Relation to Chronology and Art."
H. B. Cotterill, for his paper on "A Year on the Nyassa, with Notes on the Slave Trade, and on the Prospects and Means of Opening up the Surrounding Country."
Sir Joseph Fayrer, M.D., K.C.S.I., for his paper on "The Destruction of Life in India by Wild Animals."
W. T. Thornton, C.B., for his paper on "Irrigation Regarded as a Preventive of Indian Famine."
Col. J. T. Smith, R.E., F.R.S., formerly Master of the Mint, Madras and Calcutta, for his paper on "The Depreciation of the Value of Silver, with Especial Reference to the Exchange between India and England, and Suggestions for a Remedy."
F. C. Danvers, for his paper on "Agriculture in India."
James Mactear, for his paper on "Some Recent Improvements connected with Alkali Manufacture."

Visit of Artisan Reporters to the Paris Exhibition.

The Council have received from the President, his Royal Highness the Prince of Wales, the following letter:—

Marlborough-house, April 13, 1878.

Sir,—As President of the Royal Commission for the Paris Universal Exhibition, I am desirous of ascertaining what assistance can be given towards the visit of artisans, who might be delegated to examine and report upon the special technicalities of the various industries which will be displayed at this Exhibition.

Similar reports were made during the Paris Exhibition of 1867, and the Society of Arts, always foremost in promoting such undertakings, took an important part in bringing together the very valuable documents which were published at that time.

At the Vienna Exhibition, also, reports of a like nature were drawn up, and a small volume containing much interesting information was the result.

In the present instance, having undertaken the responsibility of the executive arrangements connected with the Paris Exhibition, I should be glad to hear that the Council of the Society of Arts find that it is in their power to co-operate with the Royal Commission in providing for the funds and organisation which will be necessary in order to carry out the object in view.

The Royal Commission will contribute the sum of one hundred guineas out of the vote which has been placed at their disposal for the British Section, and as a further proof of the interest which, in common with my colleagues, I take in the promotion of these visits, I propose to request certain members of the Royal Commission to form themselves into a committee for the purpose of co-operating with the Council of the Society of Arts.—I am, Sir, your obedient servant,

(Signed) Albert Edward, P.

To P. Le Neve Forster, Esq ,
Secretary of the Society of Arts.

The Council, in reply, stated that it would afford them much gratification to render such assistance as lies in their power to further the object his Royal Highness has in view, and that they (the Council) had appointed a committee to co-operate with his Royal Highness, and they had voted the sum of one hundred guineas in aid of the undertaking. The two committees have been amalgamated, and consist of the following persons:—The Earl Spencer, K.G.; the Right Hon. Lyon Playfair, C.B., F.R.S., M.P.; Mr. Sampson S. Lloyd, M.P.; Mr. Hugh Birley, M.P.; Mr. Joseph Chamberlain, M.P.; Mr. Samuel Morley, M.P.; Mr. John Mulholland, M.P.; Mr. Anthony J. Mundella, M.P.; Mr. William Hawes, F.G.S., Deputy-Chairman of the Council; Lieut.-Colonel Donnelly, R.E.; Mr. Henry Doulton; Mr. H. Reader Lack, Treasurer of the Society; Mr. H. Rawlinson, C.B.; Admiral Sir Erasmus Ommanney, C.B., F.R.S.; and Mr. W. H. Perkin, F.R.S., with Mr. P. Le Neve Foster, M.A., Secretary. They have placed themselves in communication with firms and employers of labour in the principal trades of the metropolis, as well as with a large number of towns, the seats of leading manufactures in the United Kingdom. They are also in communication with a committee of artisans. By this means the committee have every reason to believe they will be able to make a satisfactory selection. Arrangements are already made in Paris, through the agency of the Royal Commission, for the reception of the men, and for their lodging and board at very moderate rates of charge. A subscription has been set on foot to defray the cost of the undertaking, and already the following are promised:—

	£	s.
Her Majesty's Commissioners for the Paris Exhibition	105	0
The Society of Arts	105	0
His Royal Highness the Prince of Wales, President of the Royal Commission	50	0
The Worshipful Company of Fishmongers	26	5
The Worshipful Company of Carpenters	10	10
Earl Spencer	26	5
The Worshipful Company of Drapers	52	10
The Worshipful Company of Salters	10	10
The Worshipful Company of Mercers	52	10
The Worshipful Company of Clothworkers	100	0
The Builders' Association	21	0
Samuel Morley, M.P.	50	0

The amount already subscribed must be taken merely as a commencement, and the Council invite contributions from the members, to aid their President in making this truly national work a complete and thorough success.

Examinations.

These continue to attract an increased number of candidates, and as regards the Technological Examinations, in a very remarkable degree. This is very largely due to the stimulus which the Society has, through the liberality of the Clothworkers' Company, been able to offer for the formation of classes in Technological subjects. The above Company placed at the disposal of the Society a sum of two hundred pounds, for payments to teachers of technological subjects on the results of their instruction in Technology, testified by the number of successful students passing the Society's Examination. The effect of this offer has been very remarkable; and it is expected that, if the offer be renewed, a still larger measure of success will be obtained in future years. The increase has been from 68 candidates last year to 184 in the present year. The full details of the examination

will be found in the Educational Officer's report, printed in the last number of the Society's *Journal.*

In connexion with the Technological Examinations, the Council feel that they cannot allow to pass without notice the recent report by the Committee of the Livery Companies of London on Technical Education. The report has already been printed *in extenso* in the *Journal*, and has, doubtless, been read with interest by the members. For many years the Society has been endeavouring to improve the condition of technical education in this country. It has appointed several committees at different times, numerous papers have been read before it, and six years ago it set on foot its Technological Examinations, thus making the first effort to provide a practical system of education for our artisans in their respective industries. During those six years it has been up-hill work to carry out this scheme, and it is, therefore, with feelings of special satisfaction that the Council look forward to being able to transfer to the future "London Institute" the work they have thus set on foot. The scheme put forward by the Guilds has much to recommend it; it is practical, it proposes to do the work gradually, beginning by establishing, or assisting the establishment, of local schools, and thus preparing the way for that great central institution which it is the hope of those interested in technical education to see eventually founded in London. There cannot but be great hope for the future of an institution thus wisely and judiciously commenced; and the Council, in expressing their warmest hopes for its success, feel that they may justly congratulate those who have conducted thus far their important and difficult undertaking.

Blowpipe Apparatus.

The increasing importance of a ready use of this little instrument as a means of research is becoming more and more apparent, and especially amongst those engaged in our mining districts and in metallurgical operations. In order to promote this study, which although carefully taught for a long time past in mining schools in Germany, is not in any extended sense made part of a student's curriculum in this country, the Council thought it right last year to add this branch of work to their list of subjects in the Technological Examinations. The examination is of a practical character, and has, both this year as well as last year, been successful in gathering together in Cornwall an earnest, though at present small, band of student competitors. There is every reason to expect that these numbers will increase as the examination becomes more generally known. It early came to the knowledge of the Council that this study, especially amongst the artisan class, was impeded by the cost of procuring the needful apparatus, and, therefore, they offered a prize for the best set of blowpipe apparatus, to be sold retail for one guinea. Col. A. A. Croll, one of your members, placed a sum of £10 10s. at the disposal of the Council, as a prize, to which was added the Society's medal. The members will be glad to learn that the offer has been attended with success. Sundry competitors appeared, and, after a careful consideration by a committee of experts, the award has been made in favour of Messrs. Letcher, of St. Day, Cornwall, whose set, for completeness and portability, is thoroughly deserving the reward gained.

Silversmiths' Work.

The attention of the Council was called by Mr. Watherstone to the condition of the silversmiths' trade in this country, and to its inferior position when compared with that in foreign countries. Mr. Watherstone has generously offered to place at the disposal of the Council the sum of £100, to be offered as a prize for "The best Essay on the Art of the Silversmith, past and present, of all nations, with practical suggestions for its future development." The proposal was accepted, and under the advice of a committee, the Council now offers the prize, with the addition of the Society's medal, under the following conditions, viz.:—The competition is open to persons of any nationality, and the essay may be written in English, French, German, or Italian; the essay must be historical as well as practical, and should point out the *chefs-d'œuvre* produced in various countries. It is necessary that the obstacles which have tended to retard the progress of the art in England should be set forth, with a view to their removal; and that suggestions should be made for improvements in the various branches of the art. The essays must be sent not later than October 31st, 1878, to the Secretary of the Society.

Saving Life at Sea.

The melancholy catastrophe of the sudden sinking of H.M.S. *Eurydice*, and the concomitant loss of life, lately attracted the attention of the whole country, and the Council has had pressed upon them by nautical men the importance of drawing attention to the possibility of devising some ready means for saving life available to meet such a case as that of the *Eurydice*, where any apparatus, to be of any service at all, must have been available in the short period of five minutes.

The Council have therefore offered the Society's Gold Medal for the best means of saving life at sea, when a vessel has to be abandoned suddenly, say, with only five minutes' warning, the shore or other vessels being in sight. The medal will be awarded for the appliance, or combination of appliances, which answer in the highest degree the various qualifications named above; but the Council is at liberty to withhold the medal if, in the opinion of the Judges, nothing is submitted worthy of the award. Appliances intended for the competition must be sent in not later than the 1st August, 1878, addressed to the Secretary, and must in every case be accompanied by a short description.

The following gentlemen have consented to act as judges:—T. Brassey, Esq., M.P.; Donald Currie, Esq., C.M.G.; Admiral Nolloth; Admiral Sir Erasmus Ommanney, C.B., F.R.S.; Capt. Price, R.N., M.P.; Admiral A. P. Ryder; Admiral Sir E. Sotheby; Capt. Toynbee. Full particulars and conditions may be had on application to the Secretary.

Extinction of Fires.

On the subject of the extinction of fires, investigated some time since by a Committee of this Society, whose conclusions were in the main

affirmed, after a more full examination, by a Select Committee of the House of Commons, it may be stated, that those conclusions have received recent further corroboration on all points. It is to be noted that the Corporation of the City of London have made an advance in the protective arrangements recommended for general adoption, by hydranting the streets of the City. It is hoped that they will soon present an example of further progress, by having the implements, the hose, as well as the hydrants, in constant readiness, by having them in constant use for the cleansing the pavements, and preventing the slipperiness which is detrimental to the asphalte pavement there. The change proposed in the Committee'sreport, for the one object of fire prevention, involved the placing the whole of the water supplies under unity of management on a public footing, and the conversion of the police force into a great fire patrol of trained firemen. The change to unity of management on a public footing has also been urged with increasing strength of evidence, as the first great step for the improvement of the supplies of water for domestic consumption. The great obstacle to the change of system has, hitherto, been the question of compensation to the shareholders of the companies. There have been recent discussions in Parliament of the terms of compensation in such cases, which it is considered would serve to remove that obstacle. On a renewed examination, it appears that the economies derivable from unity are greater than were estimated by our committee, and will enable the change to be made with advantage to the shareholders as well as of the public. The elements of progress on this question are elaborated in a separate paper by Mr. Chadwick, the Chairman of the Committee, which will be published with other papers brought before the Congress on the question of the water supply. It is to be regretted that, from the state of public business in Parliament, this subject has not yet had the place which the Government had conceded to it.

Street Pavements.

The researches of the Committee on this subject, it is satisfactory to observe, have not entirely failed of their effect; the report being constantly referred to as of authority in the discussions of administrative bodies.

Owen Jones Prize.

The Council of the Society of Arts are trustees of the sum of £400, presented to them by the Owen Jones Memorial Committee, being the balance of the subscriptions to that fund, upon trust to expend the interest thereof in prizes to "students of the Schools of Art, who in annual competition produce the best designs for household furniture, carpets, wall-papers and hangings, damask chintzes, &c., regulated by the principles laid down by Owen Jones;" the prizes to "consist of a bound copy of Owen Jones' 'Principles of Design,' a bronze medal, and such sums of money as the fund admits of." The prizes will be awarded on the results of the annual competition of the Science and Art Department. Competing designs must be marked "In competition for the Owen Jones Prizes." The first competition takes place in the present year, and a considerable number of works has been sent in, but the award cannot at present be made.

Honorary Life Membership.

During the year the Council, acting on the powers conferred by the Bye-law 66, have conferred a Life Membership on Mr. Alexander Graham Bell, the inventor of the Telephone, and on Mr. H. M. Stanley, whose explorations in Africa cannot fail to be attended with important results to commerce hereafter. It will be remembered that last year a similar recognition was given to the labours of Lieutenant (now Captain) Cameron, C.B.

Finance.

The usual accounts of the Society's receipts and expenditure, with statement of assets and liabilities, have already been published in compliance with the Bye-Laws in the Society's *Journal* of last week. It will be noticed that a considerable sum has been expended in replacing the lanthorn in the Great Room, and in laying hot-water pipes for warming the Society's house, an expenditure which could not be placed to revenue account, but falls necessarily on some of the accumulated funds of the Society.

The Chairman having remarked on the interesting character of the report, moved its adoption, which was seconded by **Mr. Campin.**

Mr. Ford said he could not agree with the Chairman, though no doubt the report might be made interesting if a great deal were put into it which was not there. It was painful to him to see so few members present, which he thought was due in great extent to the hour at which the meeting was held, though it might be occasioned by the confidence felt by the members generally in the Council. He would move as an amendment, that the report be not adopted, but stand adjourned for a convenient time, in order that it might be circulated amongst the members.

Mr. Hale seconded the amendment for the adjournment of the meeting. He should have been glad to have heard the Chairman enlarge on the affairs of the Society; and if any member of the Society wished to give a conscientious vote on the report he ought to have an opportunity of considering it. He considered the Council was too exclusive; there were £6,000 or £7,000 of annual income, and he thought the members generally ought to have more control over the expenditure. The reading-room ought to be open in the evening, instead of only from 11 till 4 o'clock as at present, and there should be retiring-rooms for both ladies and gentlemen.* He wished to know whether the adoption of the report included the accounts?

The Chairman replied in the affirmative.

Mr. Ford said he wished to speak on the accounts.

The Chairman said Mr. Hale was at present in possession of the meeting.

Mr. Hale wished to know if he was in order in speaking to the accounts.

The Chairman said certainly. He would suggest that the amendment should be disposed of first, and he could then raise any question he liked on the accounts.

Mr. T. Hilton said the statement made by Mr. Hale was one he had heard many times. In discussing papers read at the ordinary meetings, as well as in discussing the Society's business, members were too apt to think that it was a mutual improvement society, or a sort of

* The reading-room is open every day from 10 a.m. till 4 p.m. (Saturdays excepted), and from 10 a.m. till 10 p.m. on each Wednesday during the Session.—Ed.

club for their convenience. They forgot that it was a Society for the Encouragement of Arts, Manufactures, and Commerce. If there was anything in the report which showed that the Council had neglected the primary duty of the Society for the Encouragement of Arts, Manufactures, and Commerce, no doubt the motion to postpone the consideration of the report might be fairly considered; there was, however, nothing in the report which showed any dereliction of duty on the part of the Council; but, on the contrary, it proved that the Society had been thoroughly carrying out its work, according to the principles laid down in the charter by which it was founded. With regard to the charge made that the Council and Executive were exclusive, he could say that he had been a member for some 23 or 24 years; he had known a little, either publicly or privately, of some of the gentlemen who had filled various offices as members of the Council, and during that period there had been great changes. Men of widely diverse views had been called to the assistance of the Council, and he thought it would be very wrong indeed if it were to go forth to the world that the Council was in any way an exclusive body. The question of the reading-room had cropped up now and again, but the fact was that the reading-room was as much at the service of members as they chose to avail themselves of it. It was said some time ago that the library was not available, and then members were asked to suggest a scheme by which it could be rendered more available. He knew of no difficulty with reference to the reading-room, except that there were so many other reading-rooms, and members did not join the Society for the purpose of sitting down to read, or coming in to wash their hands.

Mr. Ford said it was his painful duty to show that the Society was not fulfilling its mission.

The Chairman said Mr. Ford was out of order in speaking again.

Mr. Ford said another gentleman had been allowed to speak. He stood there as a public protest.

The Chairman said he might protest at the proper time, but now was not the proper time. He had already spoken more than once, and all that anyone else had done had been to speak to the amendment which he had proposed.

The amendment was then put and lost, only the mover and seconder voting for it, and the resolution adopting the report was carried *nem. con.*

Mr. Hale said he felt he was a little out of order in speaking on the accounts now, but it was an arrangement the Chairman had kindly entered into. In the first place, he wished to ask why were not the rules of the Society altered, so that the meeting could be held at another time.

A Member rose to order; there was no question before the meeting.

The Chairman said he had promised that Mr. Hale should have an opportunity of putting any question on the accounts. His answer was that the Council had fixed the times they thought most convenient.

Mr. Hale next asked why there was not something like a lavatory on the ground floor?

The Chairman said the Society was not a club, and did not profess to give that kind of convenience.

Mr. Hale said the age demanded it, and he asked it. He went on to ask why the reading-room was not open in the evening, and to say that the general body of members were not represented on the Council.

The Chairman said he would undertake that the time at which the reading-room should be open should be considered by the Council.

Mr. Hale asked what had the £600 for repairs and alterations been expended in.

The Chairman replied that over £300 of the sum expended was for an apparatus for warming the premises.

Mr. Hale asked the number of *Journals* given away weekly to non-members.

The Chairman—Very small indeed.

Mr. Hale said he found some £2,000 for the *Journal* and £800 in connexion with advertisements; he presumed that the £800 was an additional income to Mr. Wood for editing the *Journal.*

The Chairman said it was nothing of the kind.

Mr. Hale also wanted to know if there were any fees charged for the use of the room by other societies, and if so, why should the members not participate in what was obtained by having greater accommodation provided. He wished to know what were the emoluments, commission, and salary of Mr. Foster during the last year, and the same with regard to Mr. Trueman Wood. As far as he could make out from the books, and the statements made to him, Mr. Foster's emoluments were over £1,000, or thereabout. It was for Mr. Foster to say, if he would; but he did think that if nearly one-third of the annual subscriptions were spent, in that way it was rather too much.

The Chairman said this only showed Mr. Hale's ignorance of the Society's affairs. The salaries paid to the two gentlemen were nothing like one-third of the receipts.

Mr. Hale asked if Mr. Foster would state the amount of his emoluments.

Several Members protested against the question being answered.

Mr. Hale said he would only ask further that a fair and full report of that meeting be given to the members. He thought the outlay during the last three years for repairs and alterations had been considerable, and ought to have resulted in greater conveniences being afforded, and he complained that the transactions were not fairly and fully reported.

Mr. Ford rose to speak again, but more than one member protested against the time of the meeting being occupied.

Mr. Ford said he would move that the reading-room be kept open in the evening until 8 o'clock or such hour as was convenient.

Mr. Hale seconded the motion, which was put and negatived.

Mr. Ford said he would move it again another year. He wished to know what rules were adopted with regard to the issue of tickets for the annual *conversazione* at South Kensington. He had not the good fortune this year, as on previous occasions, to obtain an extra ticket for a member of his family. If the same rule was applied throughout, he should not object, but he knew it was not so, for he met many persons there who were not members.

The Secretary asked who they were?

Mr. Ford said the President of the College of Surgeons was one. He was told that a society at Westminster was furnished with tickets for all its members.

The Chairman said this was an entire mistake. There were rules under which the tickets were issued; one of which was that no member whose subscription was in arrear should have one.

Mr. Ford then began a speech, with the object of moving that the Council take steps to elect another President in place of the Prince of Wales, who, he said, took very little interest in the progress of the Society, which was dwindling away.

The Chairman said he could not take such a resolution, and that the remark was most inopportune, as the Prince

of Wales was taking a most active interest in the Society's affairs, as was shown by the very report they had just adopted. The board on the landing showed that the Society had been more prosperous last year than ever before.

Mr. Campin said he had been a member ever since 1846, and could not agree with Mr. Ford that the Society was going down. There were a great many things he objected to.

The hour during which the ballot is required to remain open having now expired,

The Chairman asked Mr. Campin to allow the scrutineers to present their report, which was accordingly done, and the Chairman declared the following had been elected to fill the several offices. The names in *italics* are those of members who have not, during the past year, filled the offices to which they have been elected:—

PRESIDENT.

H.R.H. the Prince of Wales, K.G.

VICE-PRESIDENTS.

H.R.H. the Duke of Edinburgh, K.G.
F. A. Abel, C.B., F.R.S.
Lord Aberdare.
Alex. H. Brown, M.P.
Sir George Campbell, M.P., K.C.S.I.
A. Cassels.
E. Chadwick, C.B.
Lord Alfred Churchill.
Hyde Clarke.
Sir Henry Cole, K.C.B.
Sir T. Douglas Forsyth, K.C.S.I., C.B.
Capt. Douglas Galton, C.B., F.R.S.
Earl Granville, K.G., F.R.S.
Lord Hampton, F.R.S.
William Hawes, F.G.S.
Sir John Lubbock, Bart., M.P., F.R.S.
Earl of Northbrook, K.C.S.I.
Robert Rawlinson, C.B.
John Simon, C.B., F.R.S.
Duke of Westminster, K.G.

ORDINARY MEMBERS OF COUNCIL.

G. C. T. Bartley.
George Birdwood, M.D., C.S.I.
F. J. Bramwell, F.R.S.
R. Brudenell Carter.
Col. Sir E. F. Du Cane, R.E., K.C.B.
Henry Doulton.
Sir U. Kay-Shuttleworth, Bart, M.P.
W. H. Perkin, F.R.S.
B. W. Richardson, M.D., F.R.S.
Major Webber, R.E.
Erasmus Wilson, F.R.C.S., F.R.S.
J. A. Youl, C.M.G.

TREASURERS.

B. F. Cobb.
H. Reader Lack.

SECRETARY.

P. Le Neve Foster.

Mr. Ford asked if the number of votes for each were not stated.

The Chairman said it was not the practice.

Mr. Ford said he would move that the number of votes given for each gentleman be returned by the scrutineers.

Mr. Campin claimed to be in possession of the meeting, having only made way for the scrutineers' report.

The Chairman said Mr. Campin was in possession. He would call on him to conclude his remarks.

Mr. Campin said he would go heartily with those gentlemen if they were improving the Society; but they should be reasonable, and not exaggerate for their own purposes some fanciful idea that had taken possession of their minds. He could not admit that they were going down-hill at all. He remembered Mr. Hawes being Chairman of the Council for four years, and though many of his views did not suit him (Mr. Campin) he made a good Chairman, and it was nonsense to say the Society was declining. He thought it would be as well if the Society could fall in with the ideas of these gentlemen, and give them the report in print before the meeting, as it would remove complaint, though as it was simply a *resumé* of what had already appeared in the *Journal* from time to time, he did not attach much importance to such a course. Another thing he would suggest was, that the ballot papers should be issued a little earlier, so as to allow more time for deliberation. Lastly, he noticed that one of the treasurers was a gentleman who held one or two onerous public offices, and he did not think he could have much time to spare for the duties of treasurer.

The Secretary explained that the treasurers' duty was little more than to sign the cheques which had been previously drawn by the order of the Council, the accounts being regularly audited once a month by a professional accountant, down even to the petty cash.

Mr. Ford moved that next year the bye-law relating to the issue of the ballot papers be read.

The Secretary said he would read it now. He did so accordingly.

Mr. Ford asked if it was also a bye-law that the annual meeting should take place at four o'clock.

The Secretary said it was. In reply to further questions, he informed Mr. Ford that the bye-laws themselves contained the regulations to be observed in making any alteration.

The following new members were then elected:—

Alcock, Samuel jun., Frederick-lodge, Sunderland.
Balbirnie, John, M.A., M.D., 3, Clarkson-street, Sheffield.
Bennett, William, Liverpool, and Heysham Tower, Lancaster.
Bischof, Gustav, 4, Hart-street, Bloomsbury, W.C.
Booth, Hesketh, Town Clerk, Oldham.
Bouch, John, J.P., Montpelier-house, New Brighton, Cheshire.
Bushell, Christopher, Hinderton, Neston, Cheshire.
Carnegie, David, 13, Prince's-gardens, S.W., and Stronvar, Loch Earn Head, N.B.
Chesshire, Edwin, 83, Newhall-street, Birmingham.
Clayton, R. C. Browne, J.P., Athenæum Club, S.W., and Glenfinnay, Torquay.
Dutt, K. M., 15, Colville-terrace West, Notting-hill, W.
Egmont, Earl of, 26, St. James's-place, S.W.
Exeter, Mayor of, Town-hall, Exeter.
Ffoulkes, William Wynne, Old Northgate-house, Chester.
Ford, William, Ellell-hall, Lancaster.
Fox, St. George Lane, St. Stephen's-chambers, Telegraph-street, E.C.
Freeman, William, The White-hall, East Dereham.
Froude, James A., 5, Onslow-gardens, S.W.
Hargreaves, John, Maiden Erlegh, Reading.
Hickin, Henry, St. John's School, Holloway, N.
Lee, Joseph C., Park-gate, Altrincham.
Macadam, William Ivison, Surgeon's-hall, Edinburgh.
McMurdo, Lieut.-General, C.B., Rose Bank, Fulham, S.W.
Marshall, Arthur John, 11, Vere-street, W.
Metcalf, Richard, Paddington-green, W., and New Barnet, Herts.
Niven, William, 31, Prince's-square, W.
Rogers, A., 38, Clanricarde-gardens, W.
Shepherd, Charles, 55, Alexandra-road, St. John's-wood, N.W.
Singh, Rajah Rampal, 15, Colville-terrace West, Notting-hill, W.
Skinner, Edward, M.R.C.S., &c., Red-hill, Sheffield.
Stott, Henry, Greetland, Halifax.
Taylor, John Robert, 8, Spencer-road, Loraine-road, Holloway, N.
Tepper, David G., 28, Bishopsgate-street-within, E.C.
Trevenen, Noel P., Hampton Court Palace.
Underwood, Martin, 92, London-wall, E.C.
Walton, Jonathan Sparke, 15, Bouverie-street, Fleet-street, E.C.
Whitehead, John, Park-hill, Higher Broughton, Manchester.

The Chairman moved a vote of thanks to the scrutineers, which was carried unanimously. He then added that it was quite an error to speak of the Council as being exclusive, since the whole number was elected each year by the members.

Mr. Hilton moved a vote of thanks to the Chairman.

Mr. Hale seconded it, and also wished the resolution to express regret at the illness which had prevented Gen. Cotton from presiding during the year.

Admiral Ommanney supported the motion. He wished the meeting to understand that the Society was under a great debt of gratitude to Mr. Hawes for the kind way in which he came forward, and had laboured so assiduously at the Council ever since the unfortunate sickness of Gen. Cotton, which took place immediately at the beginning of the Session.

The motion having been carried unanimously,

The Chairman briefly acknowledged the compliment, and the proceedings closed.

NATIONAL WATER SUPPLY.

The following are some of the communications brought before the Congress, held on the 21st and 22nd May:—

SAMUEL COLLETT HOMERSHAM.

I have the honour to acknowledge the receipt of your communication, accompanied by a copy of the letter addressed to the Council of the Society of Arts by his Royal Highness, the President of the Society, in relation to national water supply.

After careful attention and consideration, I beg in reply to state, that I have not found, and have no reason to consider that any insurmountable or even difficult physical obstacles exist to prevent the devising and constructing the necessary works for obtaining and supplying at a moderate charge an adequate quantity of pure water, that is, water well fitted for domestic use, to the inhabitants of any portion of the United Kingdom, whether the persons to be supplied occupy residences situated in populous towns and cities and other large centres of population, or reside in small towns and villages, or mansions, and dwellings situated in sparsely populated country districts.

Works adequate to obtain and ensure a regular supply of good water may usually be designed and constructed of a moderate size, and situated not far distant from where the water is wanted to be used, whenever the inhabitants themselves are really anxious to obtain, and are able and willing to pay for the supply. Indeed, I would humbly submit that but few localities can be found that have not sources within a moderate distance or near at hand that would yield ample supplies of good water.

As far as my knowledge extends, wherever a family or a number of families are in want of a supply of wholesome, useful water, the want is mainly found to arise on the one hand from a lack of knowledge as to what are the characteristics of pure water, or wholesome water properly fitted for household uses, frequently combined with unmerited satisfaction with their own existing supplies, or, on the other hand, from an unwillingness among those who require water to act together, and to incur and share the cost (moderate though it may be) of the works necessary to afford the supply.

No doubt, earnest men, who pursue science for its own sake, and experts who have made themselves specially acquainted with the qualities which characterise water best fitted for domestic use, would agree—

1. That such water should be wholesome, free from animalcules or other organisms animal or vegetable, either living or dead, and at no time or season of the year, or in periods of epidemics, liable to propagate disease or cause the death of those who drink it, or who use it to dilute milk, or to mix with other beverages.

2. That it should be soft and pleasant to use with soap both for washing the person and clothes, for baths, and other detergent purposes, and of a quality such as would not dissolve lead, or form a deposit or fur when boiled.

3. That it should be clear, and bright, and agreeable to the eye, and refreshing to the taste.

4. That it should be well aërated, of a useful uniform normal temperature, and not, like river or surface water, unduly warm in summer or unduly cold in winter, and so, as in the latter case, liable to be readily frozen in the distributing and service pipes.

Though simply to enunciate the above propositions would probably suffice to obtain the hearty assent of every earnest and unprejudiced person well informed on the subject of water supply, yet, to take the case of the metropolis as an example, on investigation it will be found that from the general want of technical knowledge among the inhabitants concerning the characteristics of water best fitted for domestic use, as well as owing to the political and social influence of the directors and shareholders of the existing water companies, who for many years past have practically contrived to get the London companies unfairly relieved from the fear of competition, combined with the well-known fact that the companies for many years past have been expecting to be called upon to sell their works to some public body, and, in consequence, have rather turned their attention to secure large payments for the anticipated sales than to secure the interests of their consumers. It, unfortunately, happens that many considerable portions of the metropolis and the suburban and country districts around it are still supplied with water in every respect of a quality at variance with the before-named characteristics; while other portions of the metropolis are supplied with water at variance in essential respects with some of these characteristics, and this notwithstanding that powerful and costly efforts have been made, by disinterested and able scientific men and others, during the last quarter of a century or longer, to prevent the use of the worst of the present sources, and to cause the metropolis to be supplied with uncontaminated, wholesome, and soft water, possessing all the characteristics hereinbefore named.

Among those who have honourably laboured to effect these desirable objects may be named the late Mr. Robert Paten, the late Mr. Robert Stephenson, the late Professors Graham and Miller, and Professor Hoffman, the late Dr. Clark, the late Dr. R. D. Thompson, the late Dr. Lankester, the late Mr. Henry Thomas Hope, and many other earnest men of equal standing, both living and dead.

Probably, there is not to be found another large city in the whole world more admirably situated, as respects both the geological formations and the physical features of the country around it, than this great metropolis, for the ready construction of works at a moderate cost, capable of affording an abundant and adequate supply of wholesome soft water, well fitted

for all domestic purposes, as well as for the construction of covered service reservoirs situated far above the tops of the highest houses built even on the most elevated ground, for keeping the pipes constantly charged, and to convey the water into consumers' dwellings; this, further on, will be specifically alluded to.

But, while the physical difficulties of constructing works to afford an adequate supply of such suitable water, distributed on the most improved system, and the financial difficulties attending the obtaining the requisite amount of money to construct the works are small indeed; yet, mainly owing to the want of knowledge connected with water supply, not only among the great mass of the inhabitants, but among men unusually intelligent and well-informed on other matters, many portions of the metropolis are still kept wholly supplied with, and the inhabitants have no choice but to use, water from the River Thames, not only of a very inferior quality, but such as in hot weather is likely, and from past experience we may say is sure, sooner or later, in seasons of epidemic, to propagate disease and illness, and to cause premature death among many of those who drink it.

The metropolis and the districts immediately surrounding it, that are at present supplied by the metropolitan water companies, contain a population equal in number to nearly four million souls.

The population of England in 1871 amounted to less than twenty-two million, so that the metropolitan water companies supply more than one-sixth of the population of England.

This sixth portion is supplied by eight water companies, and each water company on an average supplies half a million persons.

The consumers of one company—the New River Company—number 900,000. The consumers of another—the Chelsea Company—number 210,000.

Approximately, the largest metropolitan water company supplies one million, and the smallest a quarter of a million, but the magnitude of these executed works that afford ample supplies to such large numbers is not found to have beneficially affected the quality or the cost of the water when compared with smaller works; for instance, the water for many years past supplied at high pressure on the constant system to the inhabitants of the comparatively small city of Canterbury and its suburbs can hardly be excelled, while the cost to the consumers of water in Canterbury is less than the cost to the consumers in the metropolis, notwithstanding that the dividend paid by the water company at Canterbury to its proprietors is larger than the average dividend paid by the metropolitan water companies.

After careful investigation, I cannot avoid the conclusion that, as a rule, it is not by larger and more comprehensive schemes than are common among us, that an improvement in the quality, the quantity, or a lessening of the cost of the national water supply can be effected.

For years past many places situated far apart in sparsely populated town and country districts have been beneficially supplied from one set of works; as examples, I will take two instances of such works situated near to the metropolis—one to the north, the other to the south of the Thames.

The works to the north are constructed on the Chiltern Hills, on ground at an altitude of 660 feet above the level of the sea, and supply both the small towns of Tring and Aylesbury, distant seven miles apart, and also the rural parishes of Aldbury, Aston Clinton, Bierton, Buckland, Cholesbury, Drayton Beauchamp, Halton, Hartwell, Hawridge, Stone, Wendover, Weston Turville, Wiggonton, and others, besides some mansions and many detached farmsteads and dwellings. These places collectively extend over an area of forty-seven square miles, or 30,000 acres.

The other to the south are constructed on the North Downs, on ground at an altitude of 707 feet above the sea, and furnish supplies to the rural parishes, towns, and places of Bletchingley, Caterham, Chaldon, Coulsdon, Godstone, Nutfield, Redhill, Warlingham, and Whiteleaf, besides many detached dwellings and farms. These places collectively occupy an area of forty-five square miles, or 29,000 acres. Some of these places are distant, in a straight line, seven to eight miles from others.

From both these set of works water is distributed to the consumers from covered service reservoirs, through pipes constantly charged at high pressure, having all the qualities hereinbefore named, and which characterise good wholesome water pleasant and useful for washing and general purposes.

The water from the works in the Chiltern Hills is supplied into the consumers' dwellings at only three degrees of hardness by Clark's test, and containing but seven to eight grains of mineral matter per gallon; it has no action upon lead either to corrode or dissolve it; it is well aërated, clear, bright, and wholesome; it is agreeable to the taste; it produces no fur on boiling, and is quite free from animal or vegetable organisms, either living or dead, it has at its source a constant normal temperature of about 51° Fahr.; and is of unsurpassed excellence for all domestic purposes.

No physical difficulties exist to prevent the metropolis and the whole of the suburban and rural districts around it from being supplied at a very moderate charge with water of a similar quality, on the constant system, distributed through pipes constantly charged at high pressure and carried into every consumer's dwelling. The sources for procuring adequate supplies of such water, and the means available for supplying it are clearly pointed out in two papers—one read before the Society of Arts on the evening of January 31st, 1855, and the other on the evening of May 14th, 1856, or as long as twenty-two years back.

To both of these papers I would now solicit particular attention, as, though their publication in the *Journal* of the Society has tended to disseminate much useful information, and been the means of effecting much practical good by directing attention to the enormous store and practically inexhaustible quantity of water that may be supplied of a wholesome, soft, and useful quality from subterranean sources; and this information thus disseminated has tended to forward the construction of the numerous and many important works since made for affording supplies of uncontaminated subterranean water from the chalk strata; yet these papers are not so widely known as they should be, and much of their contents is applicable to the water that may be obtained from subterranean sources, from other porous and absorbent geological formations, such as Bagshot sand, lower green sand, oolite, new and old red sandstone, and others, including magnesian and mountain limestone.

In late years, what has prevented or retarded ample supplies of wholesome and soft water being placed within reach of the consumers in London, and many

of the suburban and rural districts around it, is, doubtless, very much due to the general absence of technical information respecting water supply among the mass of the inhabitants; for there can be no doubt that if any considerable or influential portion of the metropolis understood this matter, wholesome useful water would soon replace the water now and heretofore supplied from the River Thames, the unwholesome character of which, and kindred supplies, was so ably pointed out in the paper read before the Society of Arts on the evening of May 12th, 1875.

If such knowledge was more universal, the New River Company would not be permitted, or indeed could no longer desire, to spoil the admirable normal quality of much of their water, as they do now, by conveying it from Hertfordshire to near London, through an open channel about twenty miles long, constructed canal fashion, in unlined bare earth, besides exposing much of it in large open reservoirs, thus deteriorating and contaminating the water from sun and frost, from leaves and blossoms falling into and mingling with the water, from the growth of confervæ on its surface, especially in warm summer and autumn seasons, which confervæ soon spring into life, soon die and decay, and become the *habitat* of numerous species, and enormous quantities of animalcules, both vegetable and animal, which diffuse themselves throughout and contaminate the whole mass of the water.

The Kent Company would be compelled to soften, or would find a pleasure in softening their hard but otherwise excellent water, and thus render it more useful for boiling, and detergent, and other household uses before supplying it to their consumers.

Experience seems, therefore, to point out that it is not so much by devising works of a larger or more comprehensive character than those we have long been accustomed to, that the national water supply would be likely to be improved in respect of quality, convenience of access, or cost, either in town or country, but rather that these desirable objects would be more surely attained by the further spread of national and individual knowledge of the subject.

Wherever considerable populations, such as those residing in the metropolis and the districts adjoining and surrounding it, have long been compelled to use a river water made clear and pleasant to the eye when only seen in small bulk, by passing it through a stratum of large grained water-logged sand, a coarse process known as filtration, the great mass of the people, though not satisfied, have still not sufficient technical knowledge of the subject to see the necessity for neglecting their usual avocations to exert themselves to effect a change.

If large numbers were fully aware of the ill-health, and even numerous deaths that over and over again have been clearly traced to fæcalised water, especially in seasons of epidemics, as so ably and eloquently pointed out in the report of Mr. Simon, the late medical officer of the General Board of Health, dated 13th of May, 1856, and printed by order of Parliament, and were also aware of the certainty that sooner or later, as population increases on the watershed of the Thames, the water from this river, though now abstracted by all the companies who distribute the water higher up than when Mr. Simon's report was written, must become as dangerous and, in the warm seasons of some year when an epidemic may again unfortunately visit us, as, poisonous as the water when it was taken lower down the river proved to be in the epidemics of 1848-9 and 1853-4, there can be no doubt that the river supplies would soon be abandoned.

Till this knowledge has been widely spread, and taken such hold of the mass of the people as to induce them to put sufficient pressure upon the ruling powers as to cause the Parliamentary protection, and close monopoly that for so many years past have been accorded to the purveyors of so great a necessity of life as water to be discarded, and admit of healthy and invigorating competition, the experience of the last fifty years has shown that the mere devising comprehensive schemes of water supply, even when generally acknowledged to be both meritorious and useful, would effect little or nothing towards the required improvement in quality, distribution, or cost.

That which has been found to apply to the metropolis and the suburban and the rural districts around it, there can be no doubt, in the most essential respects, is also applicable to all other populations.

Thirty years' practical acquaintance with the subject matter hereinbefore alluded to has impressed me that it is hopeless to expect much improvement in the national water supply until a serious demand for improved supplies shall emanate either from the great mass of, or from a number of earnest and influential consumers. I hope and believe that the intended discussion at the Society of Arts will disseminate much useful information, as there can be no doubt that such demand will become stronger and stronger, concurrently with the spread of information and knowledge of the ill-health and inconvenience that arise from the use of hard and polluted water, and that at last this righteous demand will become irresistible.

At present the directors of the existing companies act as though they believed that their proprietors' commercial interests are best served by ignoring the inconvenience and the ill effects that have been proved to arise from the distribution of bad water, and by patronising the spread of error rather than by resorting to improved sources and means of supply, and, as the companies can well afford to pay, they do not lack for ample and astute assistance to aid them in this course.

The just interests of the consumers, and of those who have made it their business and their pleasure to devote their energies to the construction of improved works, have also had to contend, and have still to contend, against both the well-intentioned but illogical, and the often interested means that, for the last twenty-five years, have been resorted to in order to stamp out competition in respect to water supplies.

Thus it has happened that the commercial interests of the proprietors of the existing water works have alone been promoted, and no one has been encouraged or even allowed to have a direct or other than a philanthropic interest in designing and forwarding the construction of works such as are really necessary to properly supply consumers with a good and cheap water, and the true interests of the consumers have been lost sight of or altogether ignored.

I beg to submit that an improvement of the national water supply is rather dependent on increased facilities being afforded for the construction of improved works, to obtain and distribute wholesome water at a moderate cost to those who are in want of it, than upon the design of larger and more comprehensive schemes compared with those now in use, or such as could justly lay claim to be of a national character.

On these increased facilities being afforded, it seems

to me certain that ample supplies of wholesome soft water, well fitted for all domestic purposes, at a moderate cost, would soon be forthcoming, both in town and country, partly by the construction of new and improved and competing works, and partly by those constructions forcing on the required improvement in the works now in use.

R. JACKSON, Clerk to the Chorley Improvement Commissioners.

The Chorley Improvement Commissioners, at their monthly general meeting, on the 28th ult., unanimously passed the following resolution:—

"That the Clerk be requested to write two letters, one to Mr. P. Le Neve Foster, and one to the Right Hon. Lyon Playfair, showing how the present and future supply of water for Chorley admirably illustrates the far seeing sagacity of the Prince of Wales' letter to the Society of Arts.

"That whilst Chorley is well situated for manufactures, it has no right to a supply of water from the Liverpool Corporation, except for house supply, That as a matter of fact the Liverpool Corporation does supply, to a certain extent, the water required by some of the manufacturers, but it has reached its limit in that respect and refused to supply 50,000 gallons per day applied for by a manufacturer.

"That Liverpool draws a large supply from this neighbourhood, and that the Thirlmere water in its passage to Manchester will pass through or near Chorley, and that the Chorley Commissioners consider it would be only just and reasonable that Chorley should be entitled to claim a *pro rata* supply of water by paying their fair share of the expenses of collecting and supplying the water. If some such arrangement cannot be made, towns, such as Chorley, must stand still while the large towns grow at their expense."

In connection with the foregoing, I may state that Chorley lies in the neighbourhood of coal fields, within 20 miles of Manchester, having railway communication with that town and Liverpool, yet it has not progressed as might have been expected, as will be shown by the following figures: —In 1831, the population was 9,282; in 1841, 13,139; in 1851, 12,684; in 1861, 15,013; and in 1871, 16,864.

In 1846, an Act was obtained for better supplying with water the town of Chorley by a company, which was bound to provide and keep constantly laid on a supply of pure wholesome water, sufficient for the domestic use of all the inhabitants of Chorley entitled thereto as therein mentioned, and to provide water for extinguishing fires. A domestic supply did not include water for closets, baths, horses, cattle, carriages, or any trade or business, but the company was empowered to supply water for other than domestic purposes by agreement. Additional borrowing powers were subsequently obtained.

In 1856 the undertaking of the Chorley Waterworks Company became vested in the Corporation of Liverpool, which was bound by Parliamentary enactment, at all times thereafter to afford as ample a supply of water within the Chorley district as the company would have been bound to afford, and to supply water for baths and water-closets at certain rates therein mentioned; also to supply the Chorley Commissioners with a water supply for flushing sewers, watering streets, and other sanitary purposes.

You will thus observe that for trading purposes, other than domestic or sanitary, the inhabitants of Chorley, and the neighbourhood, have no security for a water supply from the Chorley Waterworks, although from the contiguity of hills, nature has provided such supply.

GENERAL NOTES.

Education in New Zealand.—*The Colonies and India*, in a recent number, gives an account of the endowments for educational purposes. It seems that upwards of 600,000 acres of land are now set apart to provide funds for educational establishments. The Canterbury College has received as an endowment 350,000 acres of land, judiciously selected in various districts, and producing a rental of several thousands per annum. In the course of years this will no doubt prove to be of enormous value. "It is open to purchase, at any time, at the rate of £2 an acre; £700,000 is therefore the maximum at which this endowment can arrive. In addition to this, there is also a landed endowment for educational purposes, including not only the elementary schools but those of technical science, for classics and superior education, a museum and library, a college of agriculture, and a normal school for the instruction of teachers, a most useful idea." Besides these, there is the Canterbury museum and public library, and various similar institutions in the country towns. Lectures are given in the museum. Twenty scholarships of £40 a year, tenable for two years for students of schools, colleges, or under private tuition, have already been founded by the Board of Education, and it is intended to increase the number. At Dunedin, the capital of Otago, which is chiefly a Scotch settlement, there is a university and a school of art, a boys' and girls' high school, and district grammar schools; besides which there are athenæums and public libraries in nearly all the country villages. "Here, as at Canterbury, large landed endowments have been made for the above-named objects. Two hundred thousand acres have been settled upon the university. The buildings have already cost £30,000; they are handsome and well suited. As yet the number of students does not exceed 80, to instruct whom there are five professors, in addition to one of moral and mental philosophy, endowed with £600 a year by the synod of Otago. A valuable library is attached, which is intended shall be utilised as a free public library. A Royal Charter has been refused to it, and its degrees are not recognised. Nearly one thousand of the elder pupils at the other schools receive, at the school of art, instruction in freehand drawing, painting from copies, from nature, and from the human figure, designing, practical geometry, perspective, mechanical and architectural drawing

MEETINGS FOR THE ENSUING WEEK.

Mon.....Asiatic, 22, Albemarle-street, W., 3 p.m.

Tues. .. Biblical Archæology, 33, Bloomsbury-street, W.C., 8½ p.m. 1. Mr. E. A. Bridge, "Two Assyrian Incantations." 2. Mr. T. Pinches, "Notes on Babylonian Dated Tablets and Canon of Ptolemy." 3. Mr. E. L. Roz, "Egyptian Sepulchral Tablet in Soane Museum."
Royal Horticultural, South Kensington, S.W., 11 a.m.

Wed.....Entomological, 11, Chandos-street, W., 7 p.m.
Obstetrical, 53, Berners-street, Oxford-street, W., 8 p.m.

Fri.......Royal United Service Institute, Whitehall-yard, 3 p.m. Captain Cyprian A. G. Bridge, "The Progress of China and Japan in the Art of War."
Geologists' Association, University College, W.C., 8 p.m.
Archæological Institution, 16, New Burlington-street, W., 4 p.m.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,337. Vol. XXVI.

FRIDAY, JULY 5, 1878.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

CONGRESS ON DOMESTIC ECONOMY.

The Second Annual Congress on Domestic Economy was held in the Town-hall, Manchester, on the 26th, 27th, and 28th inst. The Congress was opened on the evening of the 26th by a *conversazione.* The Duke of Westminster, as President of the Congress, read the following letter from H.R.H. the Prince of Wales, President of the Society:—

Marlborough-house, S.W., 24th June, 1878.

My Lord Duke,—As President of the Society of Arts, I request your Grace to have the kindness to express to the Mayor and Corporation of Manchester my thanks for the great and cordial assistance they have afforded to the Society of Arts in holding the Congress for discussing domestic economy and elementary education in the city of Manchester, in connection with the educational institutions in Cheshire and Lancashire. The knowledge of domestic economy is the knowledge of all that makes home life moral and happy, and is at the root of the education of every young child. I rejoice that the subject has been connected with the public elementary education of the country.

I congratulate the Society of Arts and all interested in this most important subject on having the sympathetic services of your Grace as President of the Congress, to which I heartily wish the greatest success.

I am, my Lord Duke,
Your Grace's obedient servant,
ALBERT EDWARD P.,
President of the Society of Arts.

His Grace the Duke of Westminster, K.G.

The Meeting was also addressed by the Mayor of Manchester, the Right Rev. the Lord Bishop of Manchester, Sir Henry Cole, K.C.B., and the Bishop of Salford.

On Thursday the proceedings were opened by an address from the Duke of Westminster, after which the papers contributed to the Congress were either read or taken as read, and discussed in order. The reading of the papers and discussions continued during Thursday and Friday, when the Congress was closed with the usual votes of thanks.

A full report of the proceedings will be given in an early number of the *Journal.*

NATIONAL WATER SUPPLY.

The Committee on this subject have obtained replies from Sanitary Authorities, &c., to a series of queries intended to obtain information as to the supply of water in the various districts of the country. These replies, with the queries, are now published, in order that they may be supplemented by any further available information before being finally printed in the report of the Conference on Water Supply. The Secretary will be much obliged if Sanitary Authorities or Medical Officers of Health will furnish him with any corrections or additional information, not later than the 11th inst.

QUERIES.

1. Name of your locality.
2. What is the source of your water supply?
3. How many gallons per head of population is your supply?
4. Can you give any information from your own observation of sewage-polluted water spreading epidemic diseases?
5. Can you give any information, from your own observation, of sewage causing interference with health, apart from the recognised epidemic diseases?
6. Can you throw any light on the question whether—(*a.*) Water containing sewage from a district, where there is no epidemic, is injurious to health? and (*b.*) If it is not injurious, to what extent it must be diluted?
7. Can you give any information to help to solve the problem whether water is safe to drink, after any of the practised methods of purification, if it is open to the reception of the sewage from districts in which there is an epidemic?

REPLIES TO QUESTIONS 1, 2, 3, AND 4.

ASTON (Manor of).—2. Birmingham Corporation water supply, and shallow wells. 4. No.

BACUP.—1. Area of the Local Board is over 4,000 acres, population 28,500. 2. Surface water from the hill-tops, which is delivered without any kind of filtration. 3. Not known. It is a continuous supply. 4. During the past five months there have been several cases of typhoid fever, probably due to sewage contamination.

BARNSLEY.—2. The Corporation Waterworks Reservoir, at Ingbirchworth, on the Millstone-grit formation, nine miles from Barnsley. 3. About 30 gallons per day. 4. Yes, as regards typhoid fever.

BERWICK-UPON-TWEED.—2. Spring and pumped. 3. Thirty-five. 4. No.

BILSTON (Staffordshire).—2. Wolverhampton Corporation Waterworks. 3. About 10 gallons per day. 4. Can give no satisfactory information.

BIRKENHEAD.—2. New red sandstone. 3. Consumption per head per day, 27,353 gallons. 4. No.

BRADFORD (Lancashire).—2. Manchester Corporation. 4. No.

BRADFORD (Yorkshire).—2. By gravitation, from works at tributaries of Rivers Aire and Wharfe, gathered chiefly on high moorlands, above the reach of any pollution from populated districts. 3. 24 for domestic purposes. 4. No.

BOOTLE-CUM-LINACRE (near Liverpool).—2. We are supplied from the Liverpool Corporation Waterworks, the source of which water is from various wells in and near Liverpool, and from "Rivington." Bootle is almost solely supplied from the Bootle wells, the water from which is wholesome for drinking purposes, but is very hard (24° of hardness), and, therefore, unsuitable for washing

and manufacturing purposes. For 71 days in 1877 we were supplied with "Kensington" water, which is a mixture of Rivington and Green-lane (well) water. In my opinion our water should be a mixture of Bootle well water and Rivington.

Boston (Lincolnshire).—2. Miningsby reservoir; 14 miles distant. 3. Unlimited. 4. In the town the water has never been known to be sewage polluted, and zymotic disease is very rare. In the rural district the inhabitants frequently have to drink water from open canals and cattle ponds liable to sewage pollution, and I have often had to refer simple and choleraic diarrhœa and diphtheria to this cause. There has been, however, no epidemic of typhus or typhoid referable to the water supply; during the summer of 1877 there was very little diarrhœa, the heavy floods having largely diluted the sewage deposits.

Bournemouth (Urban District). — 2. Partly from springs and surface water from the hills and moorlands to the north of the town, and partly from deep well distant two miles from the town. 3. From 15 to 20. 4. I know of cases of bad diphtheritic sore throats and urticaria that have been caused by water polluted by sewer gas, which has discharged itself over water surface in house cisterns by means of waste-pipe leading directly into drain.

Bridport.—2. The Bridport Waterworks Company bring water from a distance of seven or eight miles, which water comes from the greensand. 3. This company being a private company, does not supply the whole town, but it could, and would, at the rate of 30 gallons per head per day. 4. Several epidemics of typhoid have prevailed at Bridport, one of which I have discovered, and have no doubt as to the spread of the epidemic by water from polluted wells, which wells form the water supply where the company's water is not taken.

Bristol.—2. Bristol Water Company's supply from the Mendip-hills, also private wells. 3. I recommend you to write to the secretary of the Bristol Water Company for an answer to this question. 4. Yes, I have known many cases from polluted wells into which the seeds of enteric fever have been introduced. On discovery we immediately have these closed.

Burslem (Staffordshire).—2. From the new red sandstone at "Wall Grange," eight miles distant, where it is pumped into reservoirs, and supplied by gravitation. 3. $20\frac{1}{2}$ gallons. 4. No.

Camborne Parish (Cornwall).—2. A reservoir in the parish of Crowan, three miles distant. 3. Unlimited. 4. No.

Cardiff (Urban Sanitary District).—2. Springs from the limestone districts, about five miles from Cardiff. 3. 25 gallons, according to present population. 4. Yes; on occasion of epidemic cholera in 1866, a block of houses supplied by a polluted well suffered severely and fatally; adjoining houses escaped, these being supplied with pure water; recently, well marked cases of enteric fever have been traced to similar excitant cause.

Carlisle.—2. The River Eden. 3. The daily average is 35 gallons. 4. A.D. 1858 (fully 20 years ago) the diffusion and multiplication of typhoid fever, through the agency of milk supply, was suspected, investigated, and established by Dr. Taylor, of Penrith, in this county, and published in the *Edinburgh Medical Journal* for May, 1858, page 939. Since September and October, 1857, and following Dr. Taylor's observations, many cases here and elsewhere have been recorded (as of a large dairy, lately, in Islington), putting all rational doubts of the unexceptionable validity of Dr. Michael Taylor's observations—so vitally and universally important—quite out of the question.

Carmarthen (Town).—2. Catchwater reservoirs supplemented by "Abyssinian" wells. 3. I believe about 20 gallons per head per day. 4. Yes; it did so here last year from one of our small reservoirs being polluted with typhoid fever secretions.

Chadderton (near Oldham).—2. Supplied by the Oldham Corporation. 3. Constant supply. 4. In December, 1876, there was an outbreak of typhoid fever in this district (Chadderton). I found that all the patients had their milk from one farm situated just over our boundary in a neighbouring township. On visiting the farm I found that the farmer, his wife, and two children were hardly convalescent from enteric (typhoid) fever. At the back door of the house was a deep well sunk in the sandy soil. Close to the well on the surface was an open cesspool in which the excrement of the typhoid fever patients was thrown without any admixture. The inference was that, somehow, the water of this well had found its way into the milk. I dismantled the pump, and we had not a single case of typhoid after the date of that visit to the farm. I asked the farmer what he did with the contents of the cesspool. The answer was suggestive. "Strange to say," he replied, "the cesspool never needs to be cleaned out." The reason was obvious. The excrement in a liquid state readily filtered into the adjacent well, and although the farmer or his customers must have used this filthy solution for years, the people on the farm enjoyed excellent health up till the outbreak of the typhoid fever.

Cheltenham (Gloucestershire). — 2. Spring water from the Cotteswold-hills, supplied by a waterworks company, and from shallow wells dug in sand. 3. Town Council has just purchased the works, and matters are at present in a transition state, so cannot state the gallons per head. 4. Yes.

Colchester (Essex.)—2. The principal source is from artesian wells, but there are some surface wells. 3. This cannot be correctly ascertained, as the artesian wells belong to a company and private individuals. 4. No epidemic disease has been spread by polluted water within my experience.

Colne and Marsden (Urban Sanitary District, Lancashire). — 2. Water company; the reservoir has no filter beds. 3. Very uncertain; in summer not more than five gallons per head; notices are up now to forbid swilling steps, cleaning windows, &c. 4. No.

Crompton (in the Borough of Oldham).—2. The Corporation Waterworks. 3. We are not restricted as to quantity. 4. No. Our water supply is so pure and so plentiful that I have had no opportunity of testing the effect of the use of sewage-polluted water.

Croydon.—2. Wells in the deep chalk. 3. 45. 4. Yes; but the whole matter was investigated by Dr. Buchanan, and the evidence is given in his report

on the epidemic of enteric fever in Croydon in 1875, which see.

Dawdon (Urban Sanitary Authority, comprising Staham-harbour, and two large collieries adjacent; population, 14,000).—2. Watershed, extensive area, through magnesian limestone, North-east Warden, low range of hills, Sunderland and South Shields Water Company. 3. About 10 gallons per diem. 4. Can give no information on this head, our water supply, as well as that of the surrounding district, being good, pure, and free from contamination of any kind.

Darlington.—2. River Tees. 3. Any amount; unlimited. 4. No.

Dover, &c.—2. Deep well in chalk. 3. About 30 gallons per diem. 4. Not in Dover.

Elland (Halifax).—2. Reservoirs on moorland. 3. Unlimited.

Folkstone.—2. Chalk springs, supplemented in dry seasons by wells in the lower greensand. 3. The water company supply about 500,000 gallons to a population of 15,000, but as there are both wells and springs in the town, perhaps about 2,000 do not take the company's water, but depend on the local supply. 4. I know of cases of enteric fever caused by drinking the water from shallow wells polluted by sewage.

Glossop.—2. Two large reservoirs; one two acres in extent, and another a quarter of an acre. 3. No correct means of ascertaining. 4. No.

Great Yarmouth.—2. The Great Yarmouth Water Company in part, private wells in part. 3. The company estimates a supply of 15 gallons per head per day to those supplied by it. 4. In 1875 I traced an outbreak of typhoid to milk adulterated with water containing sewage pollution. The well which yielded this water I found alongside a privy pit, which soaked into it, and in the house to which the privy belonged typhoid had then recently occurred. Several deaths were the result of this milk contamination. See also page 11 of my Report for 1876-7.

Halifax.—2. The "moors" several miles above the town. Drainage area or watershed 7,321 acres. 3. 123 gallons per head per day. 4. Yes, but could not give details in this space.

Hanley (Staffordshire, Borough).—2. From springs at Wall Grange and Leek. 3. Supposed to supply 20 gallons.

Hartlepool.—2. An excellent and abundant supply of good water from a spring about two or three miles distant, under the management of a company of subscribers; this spring affords water *ad libitum* to 50 or 60 thousand of people at a moderate charge. No connexion whatever with any river. 4. No.

Hertford.—2. Wells. 3. By water company, 30 gallons per head. Many in addition use pumps. 4. No, I cannot.

Heston and Isleworth.—2. Partly Grand Junction Water Company; partly surface wells. 3. Supply is once daily. 4. No.

Hyde (Local Board).—2. From own reservoirs, and Manchester Corporation. 3. Twelve gallons for domestic purposes, 10 per cent. for manufacturing uses. 4. I have a strong conviction that on three occasions typhoid fever was originated by use of water contaminated with sewage, viz., excrementitious soakage.

Kendal.—Population, 14,000. 2. Reservoir fed by springs and high gathering grounds of moorland in Silurian formation. 3. Constant and practically unlimited; not less than 30 gallons. 4. Several; typhoid fever from wells, and even streams, into which typhoid discharges were known to have found entrance.

Kettering (Urban and Rural).—2. Urban, from deep well two miles off, which also supplies one village in rural; rural supplied from wells in different villages. 3. Urban, unlimited and constant; rural, various. 4. Yes.

Kingston-upon-Hull.—2. The chalk formation on the Yorkshire Wolds. 3. Thirty-eight gallons per head. 4. No disease of an epidemic character has taken place here, traceable to this cause.

Kingston-on-Thames.—2. Lambeth Water Company. 3. About 30; of this I am not certain, it depends so much upon the individuals. 4. No.

Lewes (Sussex).—2. A deep well of 140 ft. into chalk. 3. 40·5 gallons per day. 4. A very well marked instance of epidemic disease being propagated (viz., typhoid) by sewage polluted water occurred in this town in 1874.

Louth (Rural and Urban District). — 2. Derived from the chalk formation. 3. Twenty gallons approximately. 4. Yes.

Lowestoft.—2. Lound Mere. 3. Unknown; as many have private wells. 4. No instance thereof.

Manchester (City).—2. The Longdendale Valley, about 20 miles from Manchester. 3. Twenty-one.

Leicester.—2. Two large gathering grounds, one of 2,600 acres at 10 miles from the town, a second of 4,800 acres, at seven miles from the town. 3. Twenty gallons per head *per diem*, from the waterworks. 4. No.

Leigh (Urban and Rural; Tyldesley Urban). —2. Partly Manchester and Bolton Waterworks; partly Ince Waterworks to Golborne township; Manch Waterworks entirely. 3. Five gallons domestic only; no information; twenty gallons per head for all purposes. 4. Have frequently found the use of well-water (polluted) co-exist with typhoid.

Margate.—2. Wells in the chalk, outside the town. 3. Constant supply; no limit. 4. I have observed polluted wells cause and spread typhoid fever, and have had them closed in consequence.

Maryport (Cumberland).—2. The River Derwent. 3. Unlimited. 4. In my opinion, it is one of the greatest sources of the spread of epidemic diseases.

Merthyr Tydfil.—2. River; on redstone; nine miles from town. 3. Practically unlimited. 4. I have known very many instances in which the use of water from wells, polluted by sewage, has been the direct cause of fever (enterie) and of diphtheria.

Morley (Urban Sanitary District).—2. Leeds Corporation Waterworks. 3. Six. 4. Not in this district. When medical officer of health for the combined districts of the Todmorden Union, I had many instances of typhoid fever being spread by

drinking water. I have traced the water down a hillside from house to house, the fever exactly following the course taken by the water. In one instance, the first case occurred at the top of the hill, and the probable cause was the contamination of the water by the drainage from a dungheap, on which was a large quantity of putrefying blood and offal. The patient was an infirm, elderly woman, who had not left her house for a considerable time. In this case I am of opinion that the sewage contamination originated the fever, which was afterwards carried forward by the water. Again, in Hebden-bridge, typhoid fever was endemic for many years in one particular locality. The hillside from which the water sprang was covered with pigstyes and open cesspools. When these were removed, the fever ceased to appear.

Mountain Ash (Local Board.)—2. Springs. 3. About 21 gallons per head per day. 4. No.

Newport (Monmouthshire).—An upland uncultivated surface resting on old red sandstone. 3. Forty, or thereabouts. 4. No. Our water supply is beyond the reach of any sewage contamination.

Norwich (Corporate District).—2. From the Norwich Waterworks Company. 3. About 14 gallons. 4. No.

Nottingham (Borough).—2. Chiefly from well, sunk in the Bunter beds of the new red sandstones at a distance from the town, except the Sion-hill well, which furnishes about 280,000 gallons per diem, which is in a populous part of the town, but a small proportion, about 70,000 gallons, out of 3,000,000, comes from the Scottholme springs in the Valley of the Lern, a source which has been very strongly condemned by the company's own advisers. 3. From Mr. Hawksley's statements (evidence given on Nottingham Water Bill, 1878) one-third of the 3,000,000 gallons supplied daily are for manufacturing purposes, which gives for domestic purposes, &c., about 12 gallons per head. 4. As medical officer of health I have only seen one case in the borough in which I could say that typhoid was communicated by drinking water. It should be mentioned, however, that I cannot answer for any share the public water supply may have in the dissemination of epidemic disease, as it is in the hands of a company who refuse me information respecting the distribution of the water from their several sources, one of which has been strongly condemned as being contaminated with sewage; the Scottholme springs and another, the Sion-hill well, which is sunk in the Bunter beds in a populous part of the town, are open to suspicion.

Oldham (Borough). — 2. From a tributary stream of the River Beal, and the collecting grounds on the hill contiguous to our reservoirs. 3. 25 gallons. 4. On farms I have ascribed typhoid fever to the pollution of the water by sewage.

Ossett-cum-Gawthorp.—2. Bathy Corporation (which derives its supply from Hatcholm and Holmforth. 3. 10 gallons per day. 4. Have had cases of epidemic disease from sewage polluted water.

Penzance.—2. The reservoirs (about a mile from the town) are filled by small moorland streams, and springs. 3. From 30 to 40. 4. No.

Peterborough.—2. At present wells sunk anywhere. But works in progress in oolite formation at Branboro Spa, Lincolnshire. 3. Will be 25. 4. For ten years we have not been without typhoid fever. Epidemic in parts of the town, parts since supplied with good water are free.

Portsmouth.—2. Springs at Redhampton. 3. 30 gallons per head (water company's figures). 4. Yes, typhoid fever.

Pudsay (Urban District).—2. Bradford system of reservoirs. Surface water collected from the moors and falls. 3. About $4\frac{1}{2}$ gallons a day from waterworks, which includes water used in flushing mains and lost in leakage. Water-carts with water from public wells also distributed in some parts of the town. 4. No.

Queensbury (near Bradford).—2. Spring and surface water. 3. Scanty in summer. 4. Yes, enteric fever.

Radcliffe (Lancashire).—2. From the Bury Corporation. 3. Unlimited. 4. No.

Rochdale.—2. Water of streams impounded in reservoirs. 3. About 13 gallons. 4. I have enquired into repeated cases of enteric fever which were unmistakably traced to the use of waters from surface wells so placed as to receive part of the sewage from neighbouring cesspools and drains.

Penton (Urban Sanitary District).—2. Pumped out of the sandstone, and conveyed in pipes over the whole pottery district. 3. Cannot say; there is, however, an abundant supply. 4. No.

Rhymney.—2. Mountain, about two miles above town. Water of the character of lake water, very soft. 3. Supply unlimited, except after a long drought, when it is only turned on during certain hours of the day. 4. Yes. The epidemic of cholera of 1866 commenced in, and was chiefly confined to, a part of Rhymney, where the people drank water from a spout, the supply of which ran within a foot of a privy. This was proved to have been the starting-point of the outbreak. In the winter of 1876, an outbreak of typhoid fever occurred in this place, which was undoubtedly due to temporary pollution of the drinking water from the drainage of two farms, liquid manure returning straight into the channel along which the waterworks water is conveyed from the collecting pond to the reservoir and filtering beds. I had previously noticed the occurrence of cases of typhoid after heavy rain, and this was explained by the fact that a heavy shower, after dry weather, washed small pools of urine, &c., from the surface of the farmyards—rocky—into the stream. Although the Local Board did not believe I was right in ascribing the outbreak to the water—the leading members being interested in the waterworks—the sewage of these farms was prevented from running into the stream, and there has been no outbreak of typhoid since.

Rochester (Urban Sanitary District). — 2. Deep wells into chalk and surface wells. 4. No.

Runcorn (Urban Sanitary Aurthority).—Population estimated approximately at 13,000. 2. The well is bored 300 feet, after which it is drilled for nearly another 100, furnishing a continuous supply of delicious water which is pumped by steam into a tank capable of containing a million of gallons. 4. Yes, certainly; diarrhœa and nausea.

St. George's and Kingswood (near Bristol).—2. Wells and springs and soft water cisterns. 3. Do not know. 4. No disease has spread for the last 20 years from sewage polluted water, but there has been and are numbers of children and others suffering from worms, in fact it is one of the chief diseases of the neighbourhood, and it is owing to the water undoubtedly.

St. Helen's.—2. From three wells bored in the red sandstone. The first formed 25 years ago. 3. For domestic use only, excluding manufacturing purposes; about 12·44 gallons. 4. No; the few wells were suspected years ago and were closed; all now drink water from the deep.

Sedgley (Upper District).—2. Chiefly wells. About five or six hundred houses are supplied by South Shields Waterworks Company. 3. Cannot say. 4. No.

Southampton (Borough).—2. From the River Itchen. 3. 30 gallons per head. 4. I have met with a few cases of typhoid or enteric fever, and diphtheria, in families who were supplied with water impregnated by sewage in filtration from dead wells and other sources—not the town water.

Sowerby-bridge (near Halifax).—2. Reservoir on moorland. 3. Unlimited. 4. See answer in Queensbury return.

Stamford (Urban).—2. Wothorpe and White water. The former is the better water. 3. The supply is constant. 4. Five years ago many of our inhabitants were obliged to use local well water. The water was often polluted by sewage from cesspools dug near the wells. Outbreaks of enteric fever were frequent.

Stonehouse (East).—2. Spring and 600,000 gallons weekly from Plymouth into our reservoirs. 3. About 14 gallons per head.

Stretford.—2. Manchester Waterworks and a few wells. 3. Cannot say. 4. Not in my district.

Stroud (Urban and Rural).—2. Urban, a reservoir; rural, springs and wells. 3. Both tanks contain about 2,200,000 gallons for urban and rural. 4. A few cases, the result of polluted well water, and in houses near canal where sewer emptied.

Sudbury (Suffolk).—2. Deep boring and pumped up to reservoir. 3. Eight; but there are private wells also in use. 4. Have traced several instances of typhoid fever directly to sewage in water—only cause. No previous infection.

Sunderland.—2. Deep well water from magnesian limestone. 3. Twenty-five gallons per day per head. 4. No.

Sussex, East (Combined Sanitary Authorities).—2. Brooks, ponds; wells, deep and surface; rain. 4. I have noted that the children who drink from "ponds" are prone to diphtheria. I have known instances of sewage polluted wells producing typhoid fever.

Taunton.—2. The Blackdown-hills (greensand). 3. The Taunton Town Council have just purchased the works of a company. Present amount is 100,000 gallons per diem—population 16,000. 4. Enteric fever was endemic here until the sewage-polluted wells in the town were closed.

Tipton.—2. Wells. South Staffordshire Waterworks supply. 3. A very free supply. 4. I have had an epidemic of typhoid fever arising from well pollution, when a water course was temporarily blocked up, and consequently there was no means for the refuse water to go away.

Todmorden (Urban Sanitary Authority).—2. Several properties have each their own water supply and with surplus sell to those who have none. 3. Can't say, but some districts have a very poor supply, parts of the year being without altogether. 4. No.

Torquay and St. Marychurch.—2. Streams collected at Toltiford, near Hennock, about eight or nine miles from here, conveyed in iron-pipes. 4. Yes.

Trowbridge (Wiltshire).—2. Springs, about seven miles distant, also a few surface wells; these latter are rapidly being disused. 3. Unlimited, where waterworks supply exists. 4. Several cases of typhoid occurred after using water of a certain well, which I had every reason to believe was sewage polluted though no analysis was made.

Tynemouth (Borough). — 2. From several reservoirs fed by springs from the Boulder clay, and from a large magnesian limestone quarry, fed by springs from the limestone and from subterraneous rocky strata. 3. Fourteen gallons per day. 4. It does; but there is no sewage pollution in this district.

Wallasey (Cheshire). — 2. Two wells. 400 feet to bottom of bore holes. New red sandstone formation. 3. About 30 gallons. 4. No. I have known typhoid from a well being sunk close to a manure heap, but not in my district.

Worcester (Urban and Rural). — 2. River Severn, chiefly; also a few wells. 3. The supply from river of good pleasant water is practically unlimited. 4. We have had none such.

Warwick.—2. Adits driven into gravel overlying the new red sandstone. 3. Twenty-three gallons. 4. I have observed that in towns the spread of epidemic disease has been more frequently traceable to faulty and unventilated drainage, or to private wells which have become polluted, than to the public water supply.

West Bromwich.—2. Wells and South Staffordshire Waterworks Company. 3. Not fixed. No means of ascertaining. 4. Not specially.

West Derby.—2. We are supplied by Liverpool, and a small number of the more rural houses have private wells. 3. The service is constant, and the supply unlimited. 4. No.

Weymouth.—2. Sutton-hills, five miles distant, from greensand and smooth chalk. 3. 28 daily. 4. No.

Whitby (Yorkshire).—2. From deep springs at Hazelhead, nine miles from Whitby, inland. 3. Consumption 15 gallons per head per diem; an equal quantity running to waste daily. The supply almost inexhaustible.

Widnes.—2. Well water from red sandstone. 3. 65·3 gallons per head per day. 4. None.

Willenhall (Local Board District).—2. Artesian well near Cosford-brook; deep wells at Tettenhall and Goldthorn-hill, and water from the Cosford-brook near Albrighton (Wolverhampton Waterworks). Month of January, 1878, quantity pumped:—Artesian well and stream, Cosford, 50,130,000 gallons; Tettenhall wells, 7,381,600 gallons; Goldthorn-hill well, 3,440,400; total, 62,952,000 gallons. 3. It is not known how much per head is supplied to Willenhall; for the whole of the townships of Wolverhampton, Willenhall, and Wednesfield, it averages 17½ gallons per head daily. It is probably less than this for Willenhall, because there are fewer water-closets than at Wolverhampton. 4. Some years ago many of the inhabitants of a small street, who drank water from an old coal-pit, suffered from typhoid fever, whilst those in the same street who used other water were not affected; when the water from the pit was no longer used the fever ceased. Typhoid fever was a somewhat common ailment in the outlying district of Shortheath, when water from shallow wells and sewage-polluted streams was drank. Since waterworks water has been supplied fever has disappeared.

Winchester (Urban Sanitary District).—2. A deep well in the chalk below the level of the River Itchen. 3. About three hundred thousand gallons are pumped up daily. The population is estimated at 18,385. A few houses use private wells. 4. I have never met with an epidemic so produced, but with many cases where fever has been associated with sewage-polluted water.

Woolwich.—2. Water supplied by the Kent Water Company. 3. Information to be obtained of the company.

Wolverhampton.—2. River Woorf, artesian well at Cosford, well at Tettenhall, and Goldthorn-hill, Wolverhampton. 3. About 17½ gallons per diem. 4. There have been several instances in this district of sewage-polluted water spreading epidemic diseases.

Worthing.—2. Deep boring in the chalk. 3. About 30. 4. Not in this district; in most places typhoid fever and diphtheria seem to have been produced.

Wrexham.—2. From a reservoir, wherein is collected water from the mountains. 3. Unlimited supply. 4. Not in Wrexham.

York (City).—2. River Ouse, above the city. 3. Thirty. 4. Yes, typhoid fever.

Replies to Question 6.

The following answers have also been received to query 6:—"Can you throw any light on the question whether—(*a.*) Water containing sewage from a district where there is no epidemic is injurious to health? and (*b*) if it is not injurious, to what extent it must be diluted":—

Bournemouth.—I am of opinion, from observation that water which is contaminated by sewage drained from human excrement, and in districts where there is no epidemic, will, in time, produce a general unhealthiness and an anæmic condition, and, when taken by those unaccustomed to it, sometimes serious diarrhœa.

Bradford (Yorkshire).—Houses contaminated with sewage air frequently cause feelings of malaise, diarrhœa, and nausea, which in many cases are followed by sore throat. Persons suffering from this cause have generally a peculiar pallid aspect, which is characteristic of drain poison.

Bristol.—Nothing definite. I much question the evidence of chemical analysis on this point. The seeds of enteric fever defy analysis. I have known water produce fever when pronounced pure by three able analysts. Chemistry can discover the presence of sewage, and therefore the contingent danger connected with it, but no more.

Burslem (Staffordshire).—In the case where a well, used as a water supply to a row of houses, was polluted by percolations from gasworks, I have noticed low types of disease amongst people and children using the water.

Cardiff.—I believe water polluted with sewage contamination in a diluted form is dangerous only when epidemic exists in the locality, from the impunity of drinking polluted water at other times.

Carlisle.—(*a.*) I would undertake to answer affirmatively as regards diarrhœa, and dysentery, and intestinal worms, and as to (*b.*) the reply which I cannot but give to sec. *a.*, constrains me to decline sanctioning the domestic use of water containing sewage, whether or not from an infected district. Without any qualification, we should inexorably prohibit any and every addition of sewage to water which is to be or may be used for drinking or for cookery. Let no idea of dilution delude us. However, it is only fair to say, as merely my own opinion, that water with no more organic matter than one grain in some seventy thousand (or a gallon) may safely and prudently be passed as healthful.

Hanley (Staffordshire).—In the rural district, where water has been obtained from a contaminated well, I have known it repeatedly cause diarrhœa and gastric fever.

Heston and Isleworth.—I have known feverish attacks, and diphtheritic sore throats, apparently produced by residence close to a sewage-polluted stream.

Margate.—I have seen it produce frequent sore and ulcerated throats, occasional diarrhœa, and general malaise in families drinking sewage water.

Merthyr Tydfil.—The process of downward intermitent filtration is in use on 20 acres of land, receiving the sewage of 40,000 persons partially. The effluent water is drank by the labourers on the farm. It contains barely one part in 200,000 of nitrates. It is wholly harmless.

Nottingham.—About four years ago an outbreak of diarrhœa . . . was, in my opinion, undoubtedly due to the impurity of the water, which at that time was derived from a well sunk in the sandstone, on the spot in the centre of the town.

Portsmouth.—Ordinary diarrhœa and infantile diarrhœa.

Rochdale.—The use of water from the same class of well containing a large excess of saline matter, particularly sulphates derived from a sewage sodden soil, has very often seemed to me

the only possible cause of many cases of dyspepsia turning into dysentery.

Southampton.—Persons exposed to sewage effluvia are affected more or less by sickness—diarrhœa, &c. I consider such effluvia capable of producing blood poisoning, and a predisposing cause of disease.

Torquay.—Only in cases when the private drainage of a house has been in very great disorder, but have had many sad cases occasionally, however, from escape of sewer gases.

Warwick.—Judging from numerous cases which have come under my own observations of typhoid fever, diphtheria, and diarrhœa which have been carried by well-water polluted by sewage, though not specifically tainted, I would say that all water containing sewage is injurious, and may originate specific disease.

Worcester.—I frequently traced diarrhœa, dyspepsia, and general ill-health from the use of polluted well water. The ordinary dilution of well filtered river water taken above any sewage outfall is in my opinion a safe one.

Worthing.—I know of one small town where the water supply comes from a river, which receives above the intake the sewage from the town. The sewage is enormously diluted, and no bad result seems to ensue.

Yarmouth.—I believe it does much to cause the diarrhœa Yarmouth is visited with every summer. It breaks down the health of children in particular, and paves the way for any febrile disease.

Replies to Question 7.

The following answers have been received to query 7:—"Can you give any information to help to solve the problem whether water is safe to drink, after any of the practised methods of purification, if it is open to the reception of the sewage from districts in which there is an epidemic":—

Bristol.—I believe it is not injurious. I have known many remarkable cases pointing to this conclusion. The danger of drinking such water is great, but contingent on the presence in the sewage of the seeds of disease.

Southampton.—So far as my observations have been made, I am of opinion that water may be clear to the eye, good to the taste, and yet contain the germ of sewage matter after filtration, through earth on gravelly soil, and the greatest care should be taken in the use of such water, more especially during the prevalence of an epidemic.

The following communication was brought before the Congress on National Water Supply, held on the 21st and 22nd May:—

EDWIN CHADWICK, C.B.

The full development of the question of the supply of water to the metropolis before the Congress would require a paper as long as the report of the Select Committee of the Society, which was submitted to the Government three years ago.

The present state of scientific knowledge, of hydraulic science, and of sanitary and economical science, which rules the administration of the metropolitan water supply, is displayed in a manner that requires notice, in the instance of at least one of the chief companies—the New River Company—and that in the common interests of the shareholders of all the companies, as well as of the public.

A pamphlet has recently been widely circulated, sold by Simpkin and Marshall, the head of which firm is stated to be the chairman of the New River Company. It has, hence, been received as representing the views of that company, and it, at all events, coincides with some of the evidence recently given in its behalf. The authorship is anonymous, "by a civil engineer."

Obstructive Exaggerations of Expense of Change.

The state of the special mechanical knowledge possessed by the company is displayed on one large point, which the pamphlet states—that "it is in evidence before the Select Committee of the House of Commons on the Metropolitan Fire Brigade, that the cost thereon on the householders, by making them adopt all their existing fittings to a constant water supply, would amount to about £8 per house."

The text of the evidence given by the engineer of the New River Company before the Committee was as follows:—

"3490. Do you know how many houses are supplied with water in the metropolis?—There are about 520,000.

"3497. May I take it that in your opinion it would cost something like £400,000 to alter the fittings of the houses throughout the metropolis?—At £8 a house it would; that was the estimate I made some years ago. I have not gone into the matter recently. I have no doubt that things are very much now as they were then.

"3498. Have you taken the houses supplied by your company, or generally throughout London?—Generally; it is a figure very difficult to arrive at; it was the roughest possible estimate, but I have reason to believe, taking the smaller amount required for the lower class houses, and the heavier amount required for the houses in the West-end, that the amount of £8 would probably be required to put the houses in a state to receive constant supply.

"3499. Are there not many houses in a state which would take that constant supply without any alteration?—The regulations have been enforced since the year 1872, and, under those regulations, improvements have been made which will reduce to some extent the outlay to be incurred."

This statement of the cost to be incurred by the substitution of the constant for the intermittent system of distribution, may be taken as based upon the assumption which, 30 years ago, was proved to be erroneous, *i.e.*, that the house service pipes, which bore the intermittent pressure, would not bear the constant pressure, the reverse being the fact. About that time, the late Mr. W. C. Mylne, the engineer of the same company—the New River Company—displayed to me one of the results of the hydraulic jerks, given by the intermittent system, in loosening the joints of the mains so as to suck in the coal gas that permeated the subsoil of the streets, when the mains and service pipes were empty. Early on a dry morning, to show this to me, he lighted gas accumulated over the water plugs. He gave clear evidence on the importance

and economy of uniting the house service with the mains, as parts of one system under one supervision. That idea appears to have dropped entirely out of the minds of the engineers or of the company since then. But when the "civil engineer" states that it was "in evidence" before the Fire Brigade Committee, that the cost of making the change of fittings, thrown upon the householders, was £8 per house, he might also have stated that it was "in evidence" before that same Committee, that the actual proved cost of making the change of system from the intermittent to the constant system, in Manchester, under higher pressures and greater difficulties than in London, was not more than about 11s. per house—demonstrating that the change could be effected at little above a quarter of a million, instead of the four millions as put forth. The change of system has been effected in other instances by varied means, at a cost which is only a per-centage of the expense of pumping in and out the water wasted.

What must be the state of knowledge of the directors who accept such a statement, and allow it to be put forth? and, if it be not ignorance, as it is to be assumed to be, what must be the state of the *morale* in which it is enunciated? and what the presumption of the ignorance of Parliamentary Committees, or of the representative bodies to whom it is addressed? The Vestries are largely composed of small owners of cottage property, who, it is proved, will not spend a shilling for any improvement which is to benefit the occupiers, and as such improvements are usually left to common plumbers, the cost to poor owners may really be considerable. These persistent misstatements of the expenses to be incurred are, therefore, calculated to excite strong resistance to the proposed improvements.

Overlooked Costs and Consequences of the Separation of Works.

The pamphlet propounds it as a dogma, in respect to the separate waterworks, "that the administration of the whole on one system is manifestly out of the question." It has never been in question that varied means would not be required in different districts to carry out the same system, that of the constant supply. The writer asserts "that the utmost that could be hoped for from a new administration would be that in time it might attain the practical ability of the administrations which they (the Board of Works) are so anxious to supersede."

The recommendations of the Select Committee of the House of Commons on the question of the protection of the metropolis from fire may be taken as superseding the plans of the Metropolitan Board of Works, and they may now be passed by as out of the question.*

The terms cited imply to those who are unacquainted with the subject, that the works in question are highly systematised, and cannot be altered for the better, although commission after commission, as well as Sir Selwin Ibbetson's committee, has recommended that they should be altered, in fact superseded, by placing the whole of the supplies on a public footing, as has been successfully done in increasing numbers of provincial cities.

But it is to be shown that the separate conditions of the companies are such as to baffle the application of practicable ability, for the separate attainment of proper economy either for the shareholder, or for the public. The formations of the separate areas of companies have been without regard to the physical aspects or the engineering requirements of the field of supply, viewed as a whole—without the means of laying out each sub-district so as to be within the levels of the zone of contour lines appropriate to it. They are grossly arbitrary, obstructive, and wasteful, being the "equational results," not of science, but of fierce original struggles between the companies for territory. The works, engines, reservoirs, and filter beds, mains, or service pipes of one sub-district are as independent of each other as if they were a hundred miles apart. I may show some of the consequences of these conditions of separation in the instance of the two chief companies for the supply of water to the population of the south of the Thames—the Southwark and Vauxhall, and the Lambeth companies. A short time ago there was an accidental stoppage in the works of the former company, and a temporary suspension of the supplies to a part of the district, during which there was an outcry of "a water famine." The accident might have been more extensive and prolonged, and the company might, in its isolation, have been without help, whilst, under the independent management of the other company, the Lambeth Company, there were supplies available to prevent the disaster, if there had been systematised communication between the works. On the other hand, it is stated that the Lambeth Company itself has had a perilous interruption from accident in its works, against which recourse might have been had to the supplies of the Vauxhall Company for the protection of the population of the Lambeth district. The large separate works may be taken as all liable to accidents with old machinery. The population of Chelsea sustained serious inconvenience from an accident to the company's machinery, against which relief might have been available from the contiguous district under the Grand Junction Company. Again, in the district of the Southwark and Vauxhall there are large masses of warehoused property exposed to extensive conflagration. If, at the large fire at Tooley-street, an accident had happened to the company's mains, or to the large stand pipes which give force and pressure to the supplies needed on such emergencies, enormous devastation, such as London has not beheld since the great fire, might have been the consequence—whilst, in the district of the Lambeth Company, there are high level reservoirs to contour the whole of the Southwark and Vauxhall district, with available means of protection under unity. The eastern sub-district of London has inferior protection, which the high-level reservoirs of the New River Company might supply. The first and most able organiser of the Fire Brigade, Mr. Braidwood, whom I examined on the subject, told me that, from the growth of large

* A duplicate system of supply, like that proposed by the Metropolitan Board of Works, was for a time in action in Manchester, where the people generally retained, for its softness for making tea and for other purposes, the rain water collected in butts and cisterns, together with the separate new pipe-water supply, which was considered not to be equally soft. But the duplicate supply was found to be so confusing to the servants, and so perplexing to the domestic economy, that it was necessary to abandon it, and rely solely on the pipe-water supply.

and tall warehouses, he lived in constant dread of great fires during fierce winds, against which the existing means were utterly inadequate to cope. The other day a large fire occurred amongst the warehouses in Watling-street. If it had happened during a hurricane wind in the direction of St. Paul's, the firemen were of opinion that nothing could have saved the cathedral. In the instance of the fire at the Pantechnicon, if there had been a strong gale of wind, there would have been a destruction of an immense mass of West-end house property in its direction. It appeared to our Committee of the Society of Arts that, to avert such devastation, the means must be applied which science afford, of concentrating, for the time, the entire force from the whole metropolitan area upon the district threatened. This would be effected by the union of the works of the whole area supplied by the companies. The insurance companies, which are not so seriously interested in the extinction of ordinary fires, but are largely interested in the protection of masses of property from extraordinary fires, seven years ago made serious representations to the Metropolitan Board of Works (as the authority charged with the protection of the metropolis against fire) upon the necessity of getting an union of the works of the several water companies. But these representations, and others, were met in a way to display the unfitness of that body for such a charge. Mr. Quick had years before made similar representations to the companies, and shown how the union might be affected. The pamphlet is silent upon this topic, demonstrative of the gross character of the existing arrangement, but it touches upon the question of the constant supply, which bears upon it. The companies, it says, are proceeding with the system. But in what way, and to what extent? At the end of a quarter of a century of promise, it is applied to less than one-fifth of the houses of the metropolis, and applied, for the most part, in such a way as to necessitate the retention of cisterns and conditions of stagnation which should be prevented; and also in conditions which do not effectually or considerably act to prevent waste. It is to be borne in mind, that the constant system of supply is a source of constant waste, unless there be a power of supervising the interior services of houses, which the companies, even if they had stronger motives than they have, would not be allowed by the private consumers to exercise. The general failure in this respect is demonstrated by the fact that the waste is now about as great as ever, after all that has been professed and promised to be done.

It is to be noted, that, as found in Liverpool, the reduction of waste has been attended, as was to be expected, with an augmentation of force for the extinction of fires. By this means, and by the power of the highest sources of supply being given to the lowest when requisite, it may be reckoned, that for fire extinction a third of additional force would be gained by unity of the existing works, without any of the additional works that have been proposed for the grand purpose.

Overlooked Effects of the Waste of Water on the Economy of Works.

The pamphlet passes without notice the considerable effects which the practical reduction of waste may have upon the interests, in the expenditure for works, and upon the administration in the interests of the shareholders and of the public.

The Water Committee of Liverpool report that one effect, in addition to the sanitary effects, of the reduction of the waste in the distribution of water at Liverpool, was that they obtained a sufficient quantity of surplus water to meet the probable demands of the extension of the population of the district for eight years to come; in short, to dispense with large extension works which great engineers had proposed to them as of immediate necessity. Another instance of a large economy in works is presented at Sheffield, where, by a supervision of the house service pipes, a reduction has been effected from the common rate of some of the London companies to 16 gallons per head of the population, I expect with room for further reduction. But I am informed that the result has been to render unnecessary a reservoir and works on which the shareholders had been induced to expend upwards of £400,000. I knew the late Chairman of the Grand Junction and of the Vauxhall Company, Sir William Clay, and I called his attention to the evidence of the enormous waste we had ascertained of the water distributed by the companies, amounting to three-fifths of the whole. He was at first incredulous, but was induced to make at his own seat at Fullwell a trial, which others of the present directors may be advised to repeat. He states it in a pamphlet which he wrote, and which I must further notice as applicable to the present time. The water required for daily use being pumped into the dwelling, not by manual labour but by water power, there was no motive to economise the consumption, there was a warm bath and both hot and cold water laid on to the upper floor; there were stables and washhouses. The number of inmates, including the members of the family, was twenty-four, and there could be little doubt that the consumption of water was above the average. The trial was, he declared, made with great care for ten weeks, during which the main daily supply was 13½ gallons per head. Yet the waste has been continued in the same company, the Grand Junction, of which the hon. baronet was the chairman, and last session the company applied for the sanction of Parliament for £300,000 for the extension of its distribution at its existing scale, which may be stated at 170 pails full per house per diem. But if that insanitary rate of distribution were reduced to the practicably abundant limit, including all purposes, of 16 gallons per head, the proposed extension work would be rendered as useless and as burthensome to the shareholders as well as others, as the one at Sheffield has proved to be. Indeed, if a general reduction of the mischievous waste in the metropolis were effected, and the distribution got down to one-third instead of to one-half as in other cities where the trading companies have been superseded, the whole of the intakes of the great New River Company with its directors and officers might be dispensed with, supposing that their intakes and not those from the Thames were the least eligible to retain.

Expensive Extensions coincident with continued Waste.

An example is given of the unnecessary ex-

penses to which directors have unavoidably put the shareholders, by the expenditure of a million of money for a large supply main for the East London Company upwards of twenty miles long, from the east to the west of London, that would have been wholly unnecessary under a system of unity of supply on a public footing. I am informed that there are other considerable impending outlays for extension works for other companies, for which early intervention is needed, of the like character as that of the Grand Junction; in some instances, to protect bodies of shareholders as well as the public.

It is a matter of fact which has been overlooked, that such restriction of waste as I have described must operate as a restriction of the profits of engineers, who are continuously pressing the necessity of extensions of works to meet existing conditions, and that it, moreover, operates as a reduction of the large profits on shares issued, within the company, on fixed dividends, to defray the expenses of these extensions. But a recent decision of Parliament, adopted in the case cited of the Grand Junction extension works, has imposed on the company what are called the "auction clauses"—imposed as a strict condition of the parliamentary sanction—which throws the shares upon the open market, for the lowest biddings, and preventing the distribution of the shares within the company at fixed dividends, cutting off the profits in such extensions by the application of the restrictive clauses to future cases. To some extent, however, this change operates to a reduction of the legitimate advance of the profits of the shareholders, which they were promised with the sanction of Parliament, and on which they have advanced their capital, with the supposed protection of exceptional Governmental supervision of the companies' expenditure.

Continued Waste at the Expense of the Shareholders from Multiplied Capitals, and Establishment Charges.

The credit claimed by the pamphlet for high practical administrative ability on the part of the present companies, which it were difficult for a new administration to attain, challenges the production of an illustration of the sort of management which has gone on from year to year in two of the companies which partake of the general praise. In the large districts of Camberwell, Newington, Peckham, St. George's, and the old parts of Lambeth, there are double sets of pipes or mains, one for each company, carried through the same streets, involving the expenditure of double capitals, double pipes doing half duty, double wear and tear, and double waste, double turncocks, double collectors of different and high rates to the consumers, who are held in monopoly to one or other of the companies, double rates and taxes, attended as might be expected, with little more than half the dividends promised to the shareholders, after having been for years without any dividend whatever.*

Let the case of the ordinary shareholder be here considered. He will probably have seen on the list of directors of the company, men of undoubtedly respectable position, men of business, and heads of large firms and commercial houses. He may have seen also that the accounts are audited by a government auditor, and he will have bought his shares in the confidence that "all was right." Yet it is highly probable that most of the directors may not yet be informed of those wasteful conditions, or the auditor either. Such arrangements are mostly in the hands and within the knowledge of the officers, and though the advantages of amalgamation to the shareholders might be evident, it would be equally evident that two chief engineers, two chief secretaries, and two solicitors, not to speak of two sets of directors would, in that event, be unnecessary, and there would, therefore, be ground for the *laissez faire* and *laissez passer* which have continued to prevail until now, when the like difficulties as to any reform from within must present themselves all round. The gas companies were in similar conditions, and in them amalgamations have been obtained after struggles, with the results, so far as the amalgamations have been carried, of increased dividends to the shareholders with improved supplies to the consumers at reduced rates which the directorates had declared must be absolutely ruinous. As a rule all amalgamations are economical. A conspicuous example in the metropolis is presented in the case of the steam-boat passenger companies working on the Thames, of which there were eight for a long time, yielding, under the separate directorates, very low dividends, and some of them no dividends, until they were forced to amalgamate, and place the whole field under unity, the result of which has been that the dividends have been raised ten per cent., whilst the fares to the public have been reduced ten per cent. In the instance of the water companies, however, what the public must expect is not a direct reduction of rates, but the requisite supercession of bad insanitary service, such as will be hereinafter specified, and the augmentation of a paying sanitary service, and of public security—which they may get to a threefold extent—gratis, under unity of a competent administration. Schemes have been suggested for getting the water companies to amalgamate within themselves. But there are special grounds for the assumption that such a proceeding would not work with the supplies of water as it has with the supplies of gas. Moreover the pamphlet cited, as representing the views of the dominant company, and indeed of others, evinces an utter absence of perception of the conditions for such a work. If the working of the directorates be imperfect, as they are proved to be unavoidably, in their respective districts, what may be expected of them for an administration eight times greater? What can be expected from gentlemen who, in deputations to the Presi-

* The mass of jurisdictions was the occasion of perplexity in the investigation of the outbreak of cholera which occured in the district traversed by both companies, and was ascribed to the quality of the water having the name of the place, though it was possibly derived from the intake of the opposite company. The perplexity was further increased by a practice which had arisen, from accident or design, or affixing the service pipes of the house, included in the monopoly of one company, on the mains of the other without that other knowing anything about it. The gas of different companies has often been distributed in a similar manner by duplicate mains, and the service pipes from the houses allotted to one company have been ignorantly or clandestinely affixed to the mains of the other. In one instance this was discovered by an accident to the works of one of the companies which should have left the district in temporary darkness, but it was seen with surprise that it was extensively lighted, as it turned out it had long been, from the mains of the rival company.

dent of the Local Government Board, are reported to have declared that no material economy in their works or their administration was practicable?

Authoritative Recognition of the Economies derivable from Unity on a Public Footing.

Not so, however, with a former chairman of the Grand Junction and the Southwark and Vauxhall Companies—Sir W. Clay. That gentleman expressed doubts as to the general applicability of the constant system of supply, which subsequent varied practice has resolved; but he foresaw that its application would be beset with dificulties, as it no doubt is in the hands of private companies, and this subsequent experience has fully verified. Given the necessity of a monopoly of the supply of water, which he argued upon as a necessity on economic grounds, he said:—"There is no doubt, I think, that it should be, wherever practicable, vested in the hands, not of individuals, but of some authorities, municipal or other, acting in behalf of the public. For thus vesting it there are reasons which seem to me to be conclusive. A supply of water, abundant and of good quality, is so absolutely essential, not only to the public health, but even to the public morals, that it would appear on this account alone to fall within that class of functions which a government is bound to take upon itself. There is, perhaps, no other mode by which the public can be perfectly protected against the possible occurrence of some of those evils to which monopoly has been found to lead 'in private hands,' and, at all events, the cost of water will, or ought to be, less to the consumer. To private parties the supply of water is a commercial enterprise; they have a right to look for rates which will not only pay current interest on the capital expended, but as much larger a return as will be a compensation for the risk incurred. This right is founded on justice, and must always be, as it always has been, recognised by the Legislature. There is nothing in the character of a water supply which places it beyond the range of those functions which public authorities may conveniently discharge. There is no commercial acuteness required in buying and selling, no watching of markets. The works once well formed, the carrying them on may be entrusted, not only without inconvenience, but, perhaps, with advantage, to one superintending officer acting under the control of the governing authority. The parties distributing the water must, of course, be invested with very stringent powers, partaking of a police, which will, of course, be less invidiously as well as more efficiently exercised by the recognised agents of public authority, than by the servants of a company."

It is due to the memory of Sir W. Clay, to state that, although these conclusions were founded on some years of experience, as chairman of two large companies in the metropolis, there was at that time no experience of the working of any extensive water supplies in the country, except by trading companies. The conclusions set forth in our report on the water supply of the metropolis, corroborated by the independent testimony cited, have since been verified on all points by the experience of supplies on a public footing in such cities as Manchester, Liverpool, and Glasgow. Mr. Homersham, an engineer, acting for private companies, undertook at the Congress to aver that the private companies do their work more cheaply than public authorities. An answer to this is the fact (in addition to the necessities specified, of excessive expenditure in the metropolis), that the course of change from supplies by trading companies to supplies on a public footing, now extending throughout the country, has everywhere of which we have heard, been a source of satisfaction, notwithstanding the large amounts of of compensation that have been paid, and the extravagant legal expenses incurred to effect it, and the great cost of extension works, to which from their unprotected inexperience they have also in many cases been subjected. Of the economies which the directorates fail to see, it may be observed that it is only an administration in possession of the whole position that can get fully at the bottom of them, when I can undertake to say that revelations may sooner or later be made which will astonish some of those gentlemen as to the amount of waste of which many have been made unwittingly the instruments. Sir William Clay thus specified the sources of economy, which were even then (in 1849) obvious, that would be derivable from placing the water supplies of the metropolis on a public footing:—

"On the transfer of the waterworks to the public there would arise immediately a large increase of net income from three sources.

"Firstly. From the consolidation of establishments after allowing retiring pensions to such of the officers of the companies as might not be retained by the new authorities.

"Secondly. From the greater vigilance and strictness with which the rates would be collected by a public body, than they now are by the companies, and the lower per-centages on the collection when forming part of a general rate collection for municipal purposes.

"Thirdly. From the new rates to be received from the householders, or owners of houses, rather, who now refuse to take a water supply, but, in the case supposed, would be compelled to take a supply, and pay for it."

At that time he gave me items derivable from administrative consolidation amounting to £80,000 per annum, and since then they have increased in magnitude. He further stated that "A far larger, although prospective, increase would be derived from the growth of London, which would, for many years, add no inconsiderable increase year by year to the revenue derivable from a water supply. From the income thus at the disposal of the State, it would be easy to provide the means of the purchase of the waterworks property." His proposal of a surrender of the monopolies of the companies met with feeble support from his own companies, and with virulent opposition, by unscrupulous means, at great expense to the shareholders, from the directors of all the other companies. On promises to improve the qualities of the supplies, by covering the storage reservoirs, by better filtration, and by giving the constant supply where it was asked for, and to conduct the works under exceptional supervision, they obtained, unfortunately for many of the shareholders, a prolongation of their separate monopolies.

It may be satisfactory to learn that, on a recent renewed and independent examination, made by

eminent experts, at the instance of shareholders of an important amount of water stock, made by the Westminster Financial Association, represented by the Hon. Mr. Randolph Stewart, the anticipations of Sir W. Clay as to the services practicable from unity on a public footing, have received conclusive verification.

The Contract Position of the Companies Defined.

It should be more clearly understood, however, than it now generally is, as to the positive and relative position of the water companies, that their contract work is only one part of a machinery, the completion and well working of which, as laid down by the first General Board of Health, is necessary for the sanitation of an urban community. The companies contract work is to collect water from intakes sanctioned by Parliament, to store it, and filter it, and bring it into the streets, and maintain it under a given pressure, and there keep it for the connection of the private service pipes provided at the expense of the householder or consumer. In so carrying and keeping the mains in the street, the company has completed its engagement and has nothing landed property, or of the reversionary landed interests that have fallen to that corporation, as any other than an incumbrance to the proper work in hand. In the sale of its shares, the auctioneers are wont to expatiate on the value of that property, from the great interests there are in Parliament for its protection. It is to be regretted that hitherto there has been no interest so vigilant and as strong for the maintenance of the sanctity of property of another large species;—the property in the health and strength, and the life, of the population of the metropolis, of which the present position taken by the pamphlet is a continued large infringement. The maintenance of the existing conditions has been at the expense of the miserable risks of life and property from fire in the metropolis. The success of the opposition to the measures proposed by the first General Board of Health must have been at the sacrifice of more than three hundred lives and three thousand serious fires in the metropolis. Indeed, the course of resistance sustained by the pamphlet, has been (with the exception of this New River Company and of another which has touched its maximum) at the expense of the property of the general body of the shareholders.

Further Exaggerations of the Costs of Change.

In respect to the finance of the change required, the pamphlet states that, considering "that most of the companies are looking forward, and with good reason, to deriving much advantage from large additional outlays made within a comparatively recent period, it cannot be safe to put the compensation for compulsory purchase at less than 25 per cent. on the full value of the property rated on the profit of 1876. This will make the purchase money amount to £30,381,955." And even if it were so, the economies of unity, as proved before our Committee (which are overlooked, whilst the charges for new works are exaggerated, as herebefore shown), including the economies of insurance charges, and other economies, would render a purchase, even at that price, a highly paying one to the public, were it necessary, as it is proved not to be.

Now, it may be assumed to be safe to adopt, as a basis, the terms of compensation sanctioned in like cases by Parliament. A number of shareholders, who imagine that their interests in the matter are very distinct from those of the directorates in the retention of place and patronage, have shown this, and examined the data on our lines, and have found that the economies derivable from consolidation have been understated by us to the extent of full twenty per cent. Since our report, indeed, the economies practicable on a public footing, have been advanced in various ways that are specified, in a paper lately submitted to the Government, which I hope will be called for. The terms of purchase lately sanctioned by Parliament, and by Local Government Board, are of twenty-five years' purchase at the highest maximum dividend earned, and also an allowance for prospective advantages, and an allowance for compulsory purchase. On these terms, there can be no reasonable prospect of any abatement. The companies state that the maximum dividend to which they are entitled by statute is ten per cent.; but for many years some of them got no dividend at all. One now, under exceptional circumstances, only gets three per cent., and all round, including the New River Company, they only receive under eight per cent. The Directorates contend for delay, for the attainment of their maximum dividend, which, with an allowance for compulsory purchase and back dividends, would advance their remuneration to upwards of 11 per cent. Now, it is found that an augmentation of the existing dividend on a public security (which costs the public no money), by about one and a-half per cent., would cover the prospective advances to which the shareholders are entitled, and the terms of purchase on the basis sanctioned by Parliament, and that if this were converted into an immediate payment on that basis, the total amount required would not be, not thirty millions, as set forth, but £26,396,322. It is shown that the rate of augmentation of the shareholders' dividends under the administration of the Directorates has not been more than two per cent. during a quarter of a century, and at the present rate of progress, it would only attain nine per cent. in the year 1891, and ten per cent. in the year 1896. Hence it will be to the interest of the shareholders to receive, as a compromise, an immediate augmentation of their proprietary rights. It is ascertained that shareholders to a considerable amount in other companies than the New River Company are now of that opinion.

The pamphlet cited alleges as a general conclusion "that every pound of bonus given to the expropriated proprietors is an extra weight thrown upon the metropolis in one shape or other." Under some local administrators this might be so.

Economies of Change Overlooked.

This allegation, as to the expense of a change of system must, however, have been made in ignorance of the large economies derivable from the consolidation of the works on a public footing. The economies, chiefly of administration, amount to upwards of one hundred and twenty thousand per annum, besides the great economies specified as derivable from the reduction of waste. Now, the various economies capitalised, it is proved will,

after the compensations made to the shareholders on the basis sanctioned by Parliament, suffice to put the house sewers in proper order for the constant supply, to hydrant all the streets, for street cleansing, and for the reduction of the insurance risks of life and property to the rate obtained in Manchester, namely, to one-third of those to which the present water administration now subjects the metropolis. These available economies capitalised, will reverse the conditions alleged in this pamphlet, and relieve the metropolis from "the extra weight now thrown upon it in one way or another," and kept upon it, by nonfeasance and malfeasance, in legislation and administration. The capitalised economies will suffice not only to effect the primary improvements, but to attain an important increasing surplus available for further paying improvements, or reductions in the rates. The available surplus will, in 1885, amount to one million, and at the end of ten years to two millions sterling.

It is to be noted that although the companies, by their contract position, as heretofore defined, are clear of responsibility for the insanitary conmore to do. Whether the water from the street mains is afterwards spoiled by stagnancy in ill-kept cisterns, and rendered undrinkable by the absorption of the foul gases of close courts, and cesspools, and middens, as is generally the case with the supplies for the poorer classes in the metropolis, or whether the defects of the companies' filtration are mitigated by refiltration, as is done by a few well to do people; whether the waste through ill-kept drain pipes, and also the foul water from the closet and the kitchen sinks which is allowed to escape, through badly constructed house drains, and permeates the site of the house and of the town, creating an excrement-sodden malarious subsoil; all this evil is no direct fault of the companies. Nor are they indeed responsible for much of the deterioration of the quality of the water at the intake, which has been to the detriment of the saleable value of their commodity. This arises from default of the local public authorities, the river conservators or others, who have allowed increasing quantities of town sewage to be discharged into the river sources. Neither are the companies responsible for defaults in the external application of their water service, for street cleansing, or for the extinction of fires. It was proved before the Fire Brigade Committee that the companies had performed their statutory duties in that respect. There were in the streets seven hundred miles of mains, comprising the chief thoroughfares and the largest properties, ready for proper hydrants which, as it was proved before the committee, the insurance companies had for years pressed the Metropolitan Board of Works as the chief fire authority to get applied, but with the result that some eighty thousand hydrants being wanted for public use, only 697 public hydrants have yet been applied, exclusive of 475 under the charge of the police for public establishments.

Need of the Union of the House Service with the Main Service under one Authority.

The only course commonly conceived for the prevention of waste, and of excrement-sodden sites, was to compel the landlords to provide the requisite internal works. But persons in the position of owner are often difficult to find, and, moreover, the process of compulsion upon the landlord to do the work himself was a process to compel him to employ his own plumber; that is to say, the very unskilful persons, ignorant of sanitary science, whose unskilful work is the subject of complaint throughout Scotland as well as England. It was, in fact, to compel the owner to incur an indefinitely heavy expense for a result that he was naturally inclined and was led to believe to be doubtful. The consequence has been violent resistance. The exaggerated statements made in the pamphlet, of the necessity of an entire and general alteration of the house services being required for the constant system, not to speak of the expenses of the requisite renewal of house drains, are well calculated to continue and aggravate such resistance, especially on the parts of small owners, who lead in vestries.

It is due to state that these resolutions are in affirmation of principles enforced by the first General Board of Health, demonstrated by practice in a number of provincial towns, with the sanitary result of great reductions of death-rates, and with economical results of the improvement of the house property. Under common contracts the works were satisfactorily executed at less than half the expense at which they could have been done by the owners. The expense was levied by what were called "private improvement rates," by which the charges were spread over thirty years, and levied as a distributed charge upon the party benefited, the occupier. The rate for the house-sewer pipes, the soil-pan and pipe, and the sink and house-drain generally, amounted for cottage property to a rate of little more than a penny farthing a week, or less than one-fourth the usual expense of the removal of the smaller part of the putrescent matter of a house by the tub or the dry-earth system. There can be no doubt of the economical and efficient working of the principles under unity of management on a public footing as proposed.

Obstructive Mis-statements of the Exhaustion of Local Rate-paying Power.

The opposition and non-feasance of the Vestries, or the Board of Works, as respects the hydrants, has been, on the score of the expense, here again grossly exaggerated, beyond existing provincial experience, and by the exhaustion of the local rate-paying power. From my own official and special knowledge, I may undertake to prove that such exhaustion of the rate-paying power has been generally due to mal-feasance, and in paying wages and rents out of rates, and making out-door relief the rule instead of the exception, and other contraventions of correct principle.

One-sided View of the Rights of Property Involved.

The pamphlet maintains that "the question of the rights of the properties of existing waterworks is one of far more gravity than that of the efficiency of the Board of Works," and asserts that the real character of the shares of the New River Company must give them a higher value than that of shares that are merely personal property; and then it speaks of the money, which "in faith as to the sanctity of real property, the New River Company have within comparatively recent times

expended." It is excusable that directors should express their feelings in such terms; and it is fair that they should have an explicit statement of the terms of purchase. But it is unjust even to the Board of Works to suppose that they could have contemplated any infringement on such rights, or had not formed an idea of the magnitude of the compensation which would be required. I imagine that no public administration of the water service would view the possession of the ditions and evils, arising from the present methods of distributing water in the metropolis, they are nevertheless incriminated in those evils, by such misuse of that position as tends to maintain them.

Advances Made upon First Statements as to Available Economies and Costs of Delay.

Since the report made by the Committee of the Society, there have been developments of further economies, as stated in a recent communication on the subject to the Government, which I may quote:—

"In conclusion, it is submitted that the information, in part above recited, as received subsequently to the inquiries of our select committee, and also subsequently to the latter examination of the Select Committee of the House of Commons, has, on every material point, advanced the practical remedies. It has advanced the sanitary means of the distribution of pure water without the deterioration for domestic consumption, and without the supersaturation of sites by foul waste water engendering damp and malaria. It has greatly advanced the means of reducing the losses of life and property by fire, and the danger of large conflagration in the metropolis. It has vindicated the extension of the beneficent functions of the Metropolitan Police Force. With these great advances in efficiency, it has made important advances in the economies desirable from unity of management on a public footing. The great obstacle to amendment has been the unsettled terms of compensation to the shareholders of the companies for the compulsory purchase of their undertakings. We have now presented bases of compensation, sanctioned by Parliament in like cases, that leave considerable economy to the ratepayers, and means of further reductions of unremunerative administration. But, whilst the later information now submitted extends the preventibility of the evils in question, it is a duty to represent that it proportionably augments the legislative and administrative responsibility for 'nonfeasance' and delay in the prosecution of proved practical remedies. To the delay of those remedies, as set forth in the report of our select committee, and as provided for in great part in the Bill introduced by Colonel Beresford, and supported by Captain Ritchie and other members, must be ascribed the sacrifice of not fewer than 50 lives of people burned alive, and more than 300 fires proved to be preventible, and the waste of the greater part of a million of capital in the extension of separate works that are unsuitable or needless under a system of combined works. And such will be found to be the cost of the further delay of relief from conditions which keep this metropolis for these respects behind other capitals, and even provincial cities and towns, in the application of advanced practical science for the public benefit."

The pamphlet cites the declaration of the Common Council, as the foundation of the opposition of the Corporation to the Bills of the Board of Works, that "the members of the Metropolitan Board of Works are not appointed to manage waterworks, and have no experience in, and are quite unfit to, discharge any such duties." This is manifestly true; but it is equally true in respect to those who countenance such statements as are put forth in the pamphlet cited; whose knowledge is confined to the defective conditions existing in the metropolis, and who have no practical knowledge of the improved conditions advancing in Manchester, and other provincial cities and towns, which are required for the metropolis. The remedy, which it would follow that the Corporation, who declined to undertake the work themselves, will support, is to place the works on a public footing, under the direction of experts, who have such special knowledge, and who give their undivided attention to its application, under direct responsibility to Parliament. The proved ruling principle of amendment, for the security of life and property, is that the application of the water supply should, for these purposes, be under the police, as in the chief provincial cities. It follows, under the exceptional conditions of the metropolis as respects its police, that this control must be governmental. It follows also, from the exceptional condition of the metropolis, where exceptional governmental functions in respect to the water supplies are already exercised in behalf of the population, most imperfect though they are, through a Government water examiner, as to the qualities of the water, and a Government auditor, for the control of the companies' expenditure, and whose report is submitted to Parliament;—that those same public governmental functions and responsibilities should be extended and made complete and effectual; in analogy with the best advancing provincial experience, which goes to the resumption of the public duties in respect to water supplies as a service, and the resumption of concessions of rights of trading profits. And this may, it is now proved, be done without detriment to office bearers, or, indeed, to directors, and with legitimate advantages to the shareholders, and greater advantage to the consumers and to the ratepayers. The means of accomplishing these beneficent results, the first great step in the sanitation and security of life and property in the metropolis, are now with the Government, at the door of the Legislature.

NOTICES.

MEETINGS FOR THE ENSUING WEEK.

Wed.....Society for the Development of the Science of Education, United Westminster (Endowed) Schools, Alexandra Schools, Victoria-street, S.W., 7.30 p.m. Mr W. Cave Thomas, "The Limitation of Brain Power in Reference to Education."
Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.
Royal Botanic, Inner Circle, Regent's-park, N.W., 2 p.m. Fruit Exhibition.

Thur....Royal Historical, 11, Chandos-street, W., 8 p.m. 1. Dr. Heinemann, "The History of Prussia in the Nineteenth Century." 2. Rev. Charles Rogers, "The Study of History, with Special Application to Scotland."

Fri.......Queckett Microscopical Club, University College, W.C., 8 p.m.

Sat......Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,338. Vol. XXVI.

FRIDAY, JULY 12, 1878.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

CHAIRMANSHIP OF THE COUNCIL.

At their first meeting after the annual election the Council elected as their Chairman Lord Alfred Churchill.

A vote of thanks was also passed to Mr. William Hawes, F.G.S., for his services as Deputy-Chairman during the past year; and a resolution expressing the regret of the Council that Major-General Frederick Cotton, C.S.I., had been prevented by ill-health from attending to the duties of Chairman during his year of office.

NATIONAL WATER SUPPLY.

The following are some of the communications brought before the Congress, held on the 21st and 22nd May:—

JOSEPH LUCAS, F.G.S.

What the Difficulty is.

The practical difficulty of the water question, as it appears to me, presents itself in respect of two cases.

Case 1. First—That of great cities and populous towns.

Case 2. Second—That of smaller towns, and villages, and scattered populations.

Case 1. In the first case we have dense populations requiring enormous quantities of water, to meet which adequate sources are few, and generally distant. These large centres are represented by wealthy corporations, whose aim, each for itself, naturally is to become possessed of the nearest of these sources, regardless of cost.

Case 2. In the second case, we have more or less scattered populations, with small requirements, and generally within reach of adequate sources, but oftentimes in ignorance of their proximity. They are generally represented by local boards, or rural sanitary authorities, who are properly averse to expense on account of their general poverty. For this reason they are frequently unable to avail themselves of sources within their reach, but of which they are in ignorance, from not being able to afford the advice of skilled experts.

What has been done to meet it.

To meet cases requiring financial assistance there have been some recent important legislative enactments. Towards the case of small towns, rural, and village districts, the Local Government Board Act affords special facilities for the acquisition of capital which could not be raised from their own resources, and the Reservoirs Act enables owners of land to develop the resources of their estates so as to collect water from any pure source of which they may have the knowledge, and supply it to any sanitary authority within reach.

There Government action stops—the State will not find water.

What remains to be done.

The successful working of the system of imperial machinery thus provided imports a knowledge of the sources of supply. It follows that, if this knowledge were before the public, the machine would be in active operation—but it is not. In other words, the populations interested would now be supplying themselves—which they are not. The logical conclusion is, that the real stumbling-block to the practical solution of the water question of the country in general is not, as has been alleged, its cost, but the general absence of data respecting its sources; and in this lies the gist of the measure I have to describe.

Thus, as it appears to me, and in my humble judgment, a supplementary measure, providing for the formation of a national survey of the sources of water supply, would act as a motive power to set existing machinery in motion, and thus facilitate the acquisition of water under the provisions of the Acts of Parliament that already exist.

The sources of water supply are of two kinds, viz., surface and subterranean, which correspond broadly with impervious and permeable strata. Except in the case of tank storage, all water supply is derived directly from one or the other, in view of which consideration, I was led some years ago to apply the name of "hydrogeology" to this now accredited branch of scientific inquiry.

Hydrogeology takes up the history of rainwater from the time that it touches the soil, and follows it through the various rocks which it subsequently percolates.

A hydrogeological survey investigates all the conditions under which it exists in its passage, both above and below ground, from the rainfall to the sea.

In respect of surface basins, or impervious surfaces, the tributary valleys, whose united contributions go to form the large floods in the main valleys, contain natural sites for reservoirs, naturally boggy, sometimes drained, but occasionally converted into large ponds. A series of dams constructed on these sites, on a comprehensive system, and with regard to all the interests involved, would form good retarding mediums for the downward flow of flood waters, and also afford provision for the requirements of upland rural districts during periods of drought.

In view of these considerations, it forms part of a hydrogeological survey to map all these sites, the utilisation of which as store reservoirs for water supply, would prove a great national advantage.

Many years' experience in the field has convinced me that the multiplication of moderate-sized dams, on sites such as those indicated, which are fairly plentifully distributed, would provide a supply of water, oftentimes mainly or wholly spring water, to large districts now distressed for want of the same. For these reasons I hold that it is part of the scheme of the survey to provide information as to the geological suitability of reservoir sites, viewed broadly.

Again, while the flood waters are being shed from impervious surfaces, their equivalent is filtering down into the subterranean reservoirs contained in the permeable strata.

Thus is generated a series of water systems, on which probably two-thirds of the area of England are dependent for their water supply. For this reason, as long ago as the year 1872, it appeared to me a matter of paramount importance that the form and position of these subterranean accumulations of water should be known. I therefore undertook as opportunity offered during the years 1873, 1874, and 1875, a series of observations on the chalk water system. Since January, 1876, I have devoted my whole time to the conduct of my survey, and have surveyed about 800 square miles in the Thames basin and the major portion of the county of Hampshire.

The first two sheets of the map that is the product of these surveys are already before the public, and copies are in the library of the Society of Arts.

General Principles.

The maps of the hydrogeological survey are designed to show at a glance the presence or absence of water in the rocks which outcrop at the surface of the earth. This is done by a system of colours constructed on the following principles:—

1. In respect of its presence—

The first principle of the colouring is that the part of the area of outcrop of any bed containing water is appropriately coloured blue.

2. In respect of its absence—

Impervious beds, of whatever composition, constituting barriers to the flow of water, are coloured black. Thus, if all parts of the area of outcrop of each water-bearing bed contained water, the map expressing the natural fact would consist of alternate areas of blue and black—but they do not. There is always a zone of varying width, and not necessarily continuous, at the base of each pervious bed, that, from rising above the limits of its water-system, is waterless. This zone is left white, and consists lengthwise of a series of meniscoid stripes. The areas of overflow, or low-lying tracts in the midst of the area of outcrop of an impervious bed, on which the water liberated by a boring from an underlying water-bearing bed will rise above the surface, are coloured red,—red being a conventional colour, in use upon draughts to express artificial productions, and deemed on that account the most appropriate to impart artificial effects.

1. As the limits of the water system under the area of outcrop of a pervious bed vary with the seasonal variations in the height of the water line, so as to occupy a larger geographical area at some times than it does at others, the part permanently occupied by water is coloured dark blue, and the part periodically so occupied light blue.

2. Similarly, the areas of overflow in artesian districts are coloured dark red in their minimum dimensions, and light red in the zone between that and their maximum extension.

3. Within the limits of the metropolitan area of depression, the actual variations in the extent of the modern areas of overflow being inappreciably small, and the boundaries of the original areas only approximately determinable, the modern areas of overflow are coloured dark red, and the original, light red.

The ground tints express the fact of the existence of water merely. It is necessary also to show the form and position of each water system at a maximum and a minimum epoch. The form of the water systems is shown by contour lines drawn at each successive 10 feet of altitude above Ordnance datum, by which means its position with respect to the surface of the ground—whether above or below, whether in its artesian system or under its area of outcrop—and with reference to the level of the sea, is also shown.

Under the area of outcrop, the contours of the water system at a minimum epoch are coloured dark blue, and those at a maximum epoch are coloured light blue, consistently with the ground tint. Similarly, in artesian districts, the minimum contours are coloured dark red, and the maximum light red. In the Metropolitan area of depression these artesian contours are not determinable, therefore the modern contours are coloured dark red, and the original light red.

The form and elevation of the surface of the ground are shown by contours—the new issue of one-inch Ordnance maps being taken as the basis. As regards the area of outcrop of a water-bearing bed, it is evident that the surface and water contours together supply the elements for calculating the depths of new wells; but where an impervious stratum occupies the surface, it is necessary to know the thickness or depth that would have to be traversed before reaching the water-bearing bed below, in addition to the information supplied by the artesian contour as to the height to which the water would rise. To meet this requirement, wherever possible, contours are given denoting the form and position of the bottom of the impervious stratum, or of the top of the water-bearing bed below.

So far the maps have been coloured on a principle, irrespective of artistic effect, the only modification of which is the insertion of a thin white line or margin, borrowed from the ripple mark, under each water contour on the map. Wells sunk into the water system of a pervious bed in its area of outcrop are indicated by blue spots, and wells sunk into an artesian water system, are coloured red, consistently with the principles explained above.

I would invite comparison between the areas of chalk country mapped by me, and the adjacent areas not yet surveyed. In the one case the water system is lucidly pourtrayed; in the other all is blank.

I am of opinion, therefore, that a national survey of the water-bearing strata is the measure that would best serve the present requirements of the country in general. It is an essential forerunner to the execution of any scheme of a constructive or legislative kind, and even, in my opinion, to the successful framing of such. Government would best minister to this popular want by investigating and providing the necessary data, alike to the landowner, the ratepayer, and the engineer, which no interested party can be expected to undertake on a comprehensive scale.

I give it as the result of my experience that the publication of the maps and tables of observations made by the survey would provide fresh food for engineering science, act as a stimulus to engineering enterprise, and promote engineering work. This step would leave the hands of the Government free to adopt in the future any legislative measure that might arise out of the survey, while

the engineer would also be left free and untrammelled, as now, save that instead of fragmentary evidence to work upon, he would have a uniform and comprehensive survey, and a map in which the hydrogeology of wide tracts of country are brought well under the eye.

JOSEPH PARRY, C.E., Liverpool.

In complying with the request of the Council of the Society of Arts to express an opinion as to whether a comprehensive water scheme of a national character is practicable, and if so, to explain briefly the broad features of such a scheme, I beg to state that I have long entertained a conviction, based upon personal observation and experience, that there is a pressing necessity for the adoption of national measures, not only to procure a plentiful supply of pure water for the inhabitants of small towns, villages, and hamlets, but also to improve and augment the supply of many large towns which are now inadequately provided for.

As to the sufficiency of our resources there is no question. Without going beyond the Welsh hills and the Westmoreland and Cumberland lakes, enough water of the best quality could be impounded to give a copious supply to the whole of the inhabitants of England and Wales.

The problem to be solved is mainly one of protection and distribution; protection of rivers and rocks from pollution; distribution from localities where there is a superabundance to localities where there is a scarcity.

Before proceeding to give an outline of the scheme which I venture to propound, I propose to refer briefly to some of the causes which have produced the condition of things complained of in small towns and rural districts, and some of the difficulties that will have to be surmounted in applying a remedy.

1. The monopoly enjoyed by water companies, though frequently operating beneficially, is too often detrimental to consumers. Where the chief end of an undertaking is the profit of shareholders, and there is no competition, the health, comfort, and security, of the public almost necessarily suffer.

2. The possession, or partial possession and practical appropriation, of extensive water-sheds and water bearing geological formations, by the authorities of large towns, by water companies, and by canal companies.

3. In many localities from which water has been taken for supply and navigation purposes, wants have arisen which were not anticipated when the schemes were projected. The rapid growth of population, especially in manufacturing districts, has been felt in two ways. The provision made for large towns has been exhausted much sooner than was expected, and to procure additional supplies, adequate to increasing demands, it has become necessary to have recourse to new sources at a greater distance. Meantime, in the localities where the original works were constructed, new industries have been established, hamlets have grown into villages, and villages into flourishing towns, while the rivers have been diverted for the use of others. In such cases a re-arrangement of catchment areas might, with great advantage, be effected. Under the present system the original works are retained, while additional projects have to be laid out on a sufficiently extensive scale to prevent the possibility of a deficiency for at least one generation.

4. The pollution of rivers and water-bearing rocks. The intimate connection between the water supply question and the disposal of sewage has been very fully shown in the sixth report of the Rivers Pollution Commissioners, which contains much valuable information on this subject.

5. Ignorance and apathy on the part of those whose supply is inadequate and unwholesome. A large proportion of the population of the country, comprising all ranks and conditions, use water for drinking and culinary purposes which is unfit for human consumption. Alike in the mansions of the wealthy and in the cottages of the poor, water is drawn from shallow wells and foul rivers without a moment's thought being bestowed on neighbouring cesspools and drains; and no water is more highly prized than that which derives its sparkling appearance from contact with decomposing organic matter. Nor can much surprise be felt that such a state of things should prevail in rural districts, while in this metropolis of the Empire, this centre of wealth and culture, three millions of people submit to be supplied with the filthy mixture which the London water companies draw from the Thames and from the Lee.

The consequences of using water polluted by human excrement are only fully realised when an outbreak of fever or cholera takes place, and then, unfortunately, as experience proves, the sense of danger generally passes away with the occasion that gave rise to it, without any permanent improvement being effected.

6. The cost of obtaining Parliamentary powers to construct works. When the promotion of a Water Bill for a town of 40,000 inhabitants has, in at least one instance, cost £25,000, ratepayers may well hesitate to sanction an application to Parliament. The system of granting provisional orders has greatly increased the facility and diminished the cost of obtaining powers to transfer and construct works. An extension of the system to works of greater magnitude than those to which it is now applicable is desirable.

7. The difficulty, owing to elevation, or character of subsoil, or sparseness of the population, of obtaining a supply at an expenditure which the inhabitants can afford to incur. Even in the vicinity of large towns, and within their limits of supply, there are numerous villages which could be well supplied by simply laying a few hundred yards of distributing main, but the cost of the work is found to be an insuperable obstacle to its execution, and the inhabitants continue to drink water from shallow wells contaminated with excrementitious matter.

In dealing with the difficulties to which I have thus briefly adverted, it will, I think, be admitted, that it is desirable to avoid any recommendation involving much additional Government interference, the constitution of new local authorities, or any considerable addition to the burdens of the ratepayers.

The Public Health Acts of 1872 and 1875, the Gas and Water Works Facilities Acts, and the Rivers Pollution Prevention Act, have already done

much to improve the water supply of the country, and much more may be expected from their operation in the future.

England is now divided into upwards of fifteen hundred urban and rural sanitary districts, subject to local authorities, who have been entrusted with extensive powers, and whose duty it is to exercise those powers, to insure for the inhabitants of the districts under their jurisdiction a plentiful supply of pure and wholesome water.

Nearly the whole of these sanitary authorities have appointed medical officers of health, whose influence and authority have been widely and beneficially exercised, in calling attention to impure supplies, in closing cesspools and polluted wells. The usefulness of this important office is still far from being fully developed. A considerable number of the appointments have not received the sanction of the Local Government Board, because the conditions upon which such sanction is given have not been complied with. This should be remedied by making it obligatory on sanitary authorities to obtain the Board's approval of all appointments of medical officers. There would then be better security for their efficiency; they would be more independent of local influence, and would be placed in direct communication with the Board. All medical officers should be required to describe the source and condition of the domestic and sanitary water supply within their district in their annual reports.

Much may, I am convinced, be accomplished, in the manner indicated, through the working of the organisation which has been called into existence. But it is obvious that this organisation, however wisely and firmly directed, will not be sufficient to turn to account, in the language of his Royal Highness the Prince of Wales, "The great natural resources of the Kingdom . . . . . . for the benefit, not merely of a few large centres of population, but for the advantage of the general body of the nation at large."

With this object, I beg to submit the following further suggestions and recommendations:—

1. To divide the country into water-shed districts.

2. To appoint an engineer to each of the principal watersheds, whose duty it shall be to deal with all matters relating to water supply, the pollution and appropriation of rivers, streams, springs, and underground waters.

There are 25 watersheds exceeding 500 square miles in area. These, with smaller sheds added, might be distributed in the manner I propose among fifteen or twenty engineers. Several engineers are at present engaged in the protection of public interests in rivers under Conservancy Boards, Commissioners, Fishery Boards, and other bodies. As far as practicable, all such interests, often conflicting, should be placed under the one engineer.

(*a*.) The salaries of the proposed engineers to be paid either entirely by Government or partly by Government and partly by contributions from the several sanitary authorities and other public bodies interested in the work done, and no further charge to be made for services rendered or plans prepared.

(*b*). The engineers to advise sanitary authorities on all questions affecting the water supply and disposal of sewage; but restrictions to be placed on the preparation of plans for authorities employing their own engineers, or for places exceeding a given population. To take no part in the ordinary management of waterworks.

(*c*.) To report to the local sanitary authorities any impurity or deficiency; and in certain districts to be specified to prepare plans and estimates for works required.

(*d*.) Failing action on the part of the sanitary authorities, the circumstances to be reported to the Local Government Board.

In many cases it would be sufficient to call attention to the polluted state of a supply, and explain the means by which the evil could be remedied, to insure prompt action by the inhabitants or authorities concerned. In other cases, and perhaps in numerous cases, it might be necessary to exercise compulsion. And, having regard to the interests involved, there should be no hesitation in arming the Local Government Board with compulsory powers to deal with such cases, within reasonable limits as to cost.

(*e*.) The engineers to report annually to the Local Government Board; also to report on all waterworks Bills promoted within their districts.

A system such as I have briefly sketched would form a link which is now wanting between the Government and the country; would give to the people, through their local sanitary authorities, the practical advice and assistance the want of which is often the only cause of failure to remedy the evils from which the people suffer; would spur indolent, interested, and careless authorities into useful activity; would strengthen weak authorities in proceedings against powerful landowners and manufacturers; would diminish greatly the expense and the risks of private Bill legislation; would afford means of enforcing the provisions of the Act for preventing the pollution of rivers; would diminish the present costly conflict of selfish interests; and would secure for the use, enjoyment, and benefit of the people generally the natural resources of the country.

Schemes of a more ambitious character will probably be brought before the notice of the Society, but the Council have wisely directed attention to the practicability of schemes to be proposed, and any scheme of waterworks to be seriously entertained must, I take it, be capable of being made fairly remunerative. No British Government is likely to incur an enormous expenditure in constructing works which cannot possibly produce a reasonable return upon the outlay. The difficulty of including rural districts in a comprehensive project will be at once appreciated, when it is considered that in large towns where the houses are in close proximity, and the average number of persons per acre is more than 40, water can seldom be distributed at a lower rate than 1s. in the £ on the rateable value of the premises supplied, while in some agricultural counties the average distance of houses apart exceeds 500 yards, and the average number of persons to an acre is ·09.

In rural districts the works required to provide a supply will generally be of local character. The sinking of a well, the formation of a small reservoir, the diversion of a sewer, the closing of a cesspool will in many, perhaps the majority of instances, effect the desired result.

For manufacturing districts, for districts unfavourably situated for the collection of water, owing to elevation, or to geological or hydrographical condition, it may be necessary to devise and carry out comprehensive schemes, adapted to the requirements of such districts. Whether the execution of those schemes should be undertaken by Government or otherwise is a fair question for discussion. A great deal may be urged against joint water schemes, but where small towns and villages can be included in projects for supplying large towns, no such objections can be sustained. The Rivers Pollution Commissioners recommended, "That in any scheme for the utilisation for town supply of pure water of a river basin, the wants of all neighbouring villages and hamlets should be provided for as far as practicable," and the application of this recommendation cannot fail to be beneficial.

An instance of its advantage is afforded by the Manchester Water Bill, which is before Parliament in the present Session. Several places on the route of the proposed aqueduct petitioned the Committee to be allowed to share the Thirlmere water, and the Chairman of the Committee mentioned that he had received twenty more applications of the same kind by letter. If a gravitation scheme for London were carried out, similar benefits on a much larger scale could be conferred.

In all joint schemes, and in all cases where villages and hamlets participate in the supply of a large town, I think that the supply should be given in bulk to the local authority of each place, and that large towns should not be permitted to distribute the water in townships and places which are outside of their municipal boundaries, except where such outside districts are immediately contiguous to, and practically form part of, the principal town.

In connection with this subject, I think it is exceedingly desirable to obtain a report on the unappropriated or partially appropriated upland surface waters, and underground waters, of the United Kingdom. Such a report would form a valuable basis for laying out schemes to supply the wants of the country.

Since writing the above, I have read the recent report from a Select Committee of the House of Commons on the Public Health Act (1875) Amendment Bill. The chief object of the Bill is to give power to rural sanitary authorities to enforce the provision of water supply on the owners of occupied houses, subject to certain limitations. The committee have made several important recommendations which are not embodied in the Bill, but which will, if adopted, be of considerable assistance to sanitary authorities in providing a proper supply for their districts. The Committee do not, however, attempt in the Bill or recommendations to deal with sanitary authorities who neglect their duty. There is only one recommendation to which special reference need be made here. It is—

"That a sanitary authority should have power to guarantee 10 per cent. for three years of the cost of the mains and pipes to be laid down by the water company, or seven per cent. until the water rates and water rents are sufficient to pay the company the proper return on the cost of the mains and pipes."

The Committee appear to have made this recommendation from a misunderstanding with respect to the present law on the point. They state—

"At present the law says, that if the inhabitants of a district within the limits of supply of any water company or other authority which has been appointed to supply the water, will guarantee 10 per cent. for three years of the cost of the mains and pipes to be laid down by the water authority or company, then the latter shall be compelled to lay down the mains and provide a water supply."

What the law really says is :—

"The undertakers shall cause pipes to be laid down and water to be brought to every part of the town or district within the limits of the special Act whereunto they shall be required by so many owners or occupiers of houses in that part of the town or district as that the aggregate amount of water rate payable by them annually at the rates specified in the special Act shall be not less than one-tenth part of the expense of providing and laying down such pipes."

So that water companies are not bound to lay down pipes unless the natural annual water rates from the property to be supplied amount to 10 per cent. on the cost of laying the necessary pipes. It is true that guarantees are commonly taken to cover the deficiency where the ordinary water-rates will not yield 10 per cent., but such guarantees usually extend to periods of seven or ten years, and there are cases where water authorities have refused to give a supply, notwithstanding that a guarantee of 10 per cent. for ten years has been offered.

Both the Bill and recommendations are open to the objection that they impose too much detail work, and throw too much responsibility, on the officers of the Local Government Board.

WALTER PIERCE.

The question of water supply has engaged the attention of the Council of the Liverpool Land and House Owners' Association over a long period, and the letter of H.R.H. the Prince of Wales having been very warmly taken up by the members, a resolution was passed,—"That a paper should be prepared and read by the president of the Association at the Congress in London" upon the subject.

The question is so wide, comprehensive, and important, that there appears but one answer to it, namely, that the Government should solve this important problem for the nation at large by providing the purest, softest, and an abundant supply of water, free from injury by the operations of agriculture or manufacture. In the hands of the Government its solution would be comparatively easy. The Government has already done a great work by the publication of the sixth report by the Royal Commissioners on "The Domestic Water Supply of Great Britain," in which they have pointed out that spring water, deep well water, and upland surface water, are wholesome. On the whole, the upland surface water seems to be the best and safest, looked at from a national point of view. Could an abundance of water be obtained from springs or from deep wells, a very great deal might be said in their favour. But it is well known, and clearly pointed out by the Royal Commissioners, that there are numerous wells in comparatively shallow sinkings in Great Britain most dangerous to health.

It is now generally admitted that, if water has once picked up sewage poison, it is almost impossible to rid it of the poison without boiling, or unless the water has percolated to a very great depth through the sandstone rock; and even then traces of it may be detected. Water falling on graveyards, privies, tanneries, house-middens, or newly-manured lands, and finding its way into shallow or even deep wells, and afterwards taken into the human system, must be injurious to health. This consideration alone should be sufficient to induce the Government to move in the matter. Even "Sandringham is supplied with water from shallow wells sunk near the house. These wells are all polluted by animal matters, and the waters they yield are quite unfit for dietetic purposes. It is dangerous water." Again, "of the shallow well water supplied to Osborne, a portion is of moderately good quality, and the remainder unfit for dietetic purposes." And "at Balmoral there is a well which is contaminated by drainage, and we, therefore, recommend that this well should be closed." Now, if wells, under such circumstances, are liable to contamination, what may be expected to be the condition of hundreds of thousands of wells in comparatively shallow sinkings in populous districts. No better water need be required than spring water and deep-well water if it can be depended upon as being free from organic carbon and organic nitrogen; but how is this to be accomplished? The Royal Commissioners have reported, "that the evidence of previous sewage or animal contamination is strongest in the case of spring and deep well water." And they have recommended that all the wells they examined in the metropolis, with the exception of two, should be forthwith closed.

If the choice is to be between wells or upland surface waters, all things considered, the latter appears to be the best, because the watersheds of course would be all on the surface and open to inspection, so as to keep them as free as possible from injurious and polluting matters. The waters in the lakes, or natural reservoirs, would also be seen and under control, and might be delivered free from impurities, or nearly so. The best upland surface waters are at a great distance from the principal centres of population, the distance being so considerable that even London with its great wealth would hesitate to undertake the expense of constructing the necessary works for a supply. The first condition should be, that the very best waters should be obtained, and the expense should be the second consideration. Government alone could comply with such conditions. And, to show, by a simple illustration, how easy it would be for Government to construct the necessary works, it is stated that a rate of 1d. in the pound, under the Property and Income-tax Schedules, for national purposes, will produce say £1,600,000, and this sum at 4 per cent. will pay interest on £40,000,000. The Government would lend this sum at 3½ per cent., so that the half per cent. would be left for a redemption fund, and would be amply adequate, inasmuch as the yield of the penny rate would be a yearly increasing one. Now, before a scheme could be got through Parliament, the yearly yield of a penny rate will be probably two millions, and this would pay interest at 4 per cent. on fifty millions. No company could be formed to raise so large a sum of money for such an object, unless the shareholders were promised, in the first instance, something like 8 or 10 per cent., on account of the risks to be run. Should Government undertake the works, all the ratepayers in the country would be the shareholders in the undertaking. No doubt water is so important an element that there should be no stint of it for domestic, sanitary, or manufacturing purposes. An unlimited supply, and at proper elevations, would create a use as a water-power. Water of the very best quality and abundantly should be brought to every man's door.

The Royal Commissioners have pointed out that there are very fine upland waters in various districts. Many of them find their way into lakes; but enormous quantities fall on high lands, rush into rivers and the sea, like a wild horse, without rendering any service to man on its way, and frequently do very great harm in bursting embankments, injuring railways, and in flooding agricultural lands, causing much loss to farmers, manufacturers, and others. Where there are large lakes of good order already, and where the present water levels can be made higher, the necessary works should be undertaken so as to increase the storage capacity rather than bring into existence artificial lakes; and the reasons are well stated in the following extract from the *Engineer*:—

"Mr. Bateman pointed out that when the level of the water in a natural lake has to be varied, little difficulty is met with, because the strata are retentive, the existence of the lake demonstrating this truth. His experience is, that every valley is merely the largest of a number of dislocations. He also made the remarkable statement, which we commend to the consideration of those who may have waterwork schemes in hand, that he never crossed a valley yet in which he did not find in the course of the valley, or close adjoining it, a dislocation, or fault, or crack. Therefore, in all valleys there is the difficulty and danger of coming across one of these dislocations, and having to counteract, as the engineer best can, its tendency to let water run away. With natural hollows—which must not be confounded with valleys—no such trouble exists."

It will thus be seen that we have the eminent authority of Mr. Bateman for stating that it is extremely injudicious to attempt to store water by throwing an embankment across a valley to impound the waters of a stream running down it, and that in all cases natural lakes are to be selected, even though the distance which the water has to be conveyed be augmented by the rejection of a valley in favour of a depression site.

In some such way as that pointed out by Mr. Bateman, the present good upland water might be utilised, and the quantity might be enormously increased by such a treatment as that pointed out by him.

Our rivers, as stated by the Royal Commissioners, are in a shocking state; the Thames, above the intake of the water companies, receives the sewage of a large number of towns; the river is used for bathing, the washing of sheep, cattle, and of dirty linen; and a considerable portion of the soluble organic matter of sewage makes its way to the works of the water companies, and is still present in the water distributed by them in London.

Very much the same state of things exists in

Banbury, Eton, and Windsor. And the Commissioners recommend that the Government should withhold their consent to more capital being expended on Thames water being supplied to the inhabitants of London. Then, again, the Commissioners point out that when the sewage of towns or other polluting organic matter is discharged into running water, of all the processes which have been proposed for the purification of sewage, or of water polluted by excrementitious matters, there is not one sufficiently effective to warrant the use for dietetic purposes, of water which has been so contaminated. And their conclusion is, that rivers which have received sewage, even if that sewage has been purified before its discharge, are not safe sources of potable water.

Specific poisons capable of producing cholera and typhoid fever lurk in running waters of rivers, discharged from persons suffering from those diseases. And the admixture of even a small quantity of these infected discharges with a large volume of drinking water is sufficient for the propagation of those and other diseases. It appears, therefore, that our wells and rivers are in a very unsatisfactory state. Nearly all are condemned except spring water and the deep well water, and there is a very great objection even to these waters on the score of hardness for all purposes except for drinking. If the water is hard, it must be softened at great expense by the aid of fuel, soda, or soap.

The conviction is a growing one that upland surface waters are the best from good watersheds. And if such works were undertaken on a very large scale by the Government, peat and other injurious vegetable matters could be removed, or otherwise destroyed. In this way very much the same quality of water would be delivered over the kingdom, and in abundance. We must have an abundant supply if the sanitary question is to have a share in the consideration. The present notion is to deliver as little water per head of the population as possible. There seems to be a contest among water engineers in this direction, whilst the very reverse should be the rule.

In Liverpool, for instance, when the Rivington Pike scheme was introduced to the town, stand-pipes were removed from courts and a water-tap introduced into each dwelling-house. In consequence of the great consumption of water, that state of things has been reversed and stand-pipes re-introduced into courts, so that one water-tap has to do the work now for, say a dozen houses. Of course there has been a great saving of water, but it was not a wise policy to make the change. In wet and dry weather the courts are almost constantly wet, the children's feet and clothing become saturated, and the floors of the houses are hardly ever dry and clean. All sorts of schemes are resorted to with a view of delivering as little water as possible. The water engineer has patented a water-meter, an enormous expenditure is incurred in searching for leakages in the mains and water-pipes; numerous inspectors are constantly harassing and annoying owners of property in examining water-taps in houses lest any water should be wasting. Many builders have to pay for repairs and replacing cisterns sums amounting to more than the water-rate three or four times over.

As far as practicable, all the waters that fall on hard impermeable rock, where the population is small, and where there is but little cultivation, should be caught and brought into contribution, so as to render service to man before finding their way into the sea. Were the Government to construct works in the localities where the best waters are, and bring them by culverts, aqueducts, conduits, and pipes to given centres, and at proper elevations without the need of pumping, this is about all that it might be expected to do. In other words, all that is intended is to bring the very best lake waters much nearer large populations. In a climate like that of England it is of the utmost importance that every care should be taken, as the rainfall in different parts of the kingdom varies in round numbers from 20 to 100 inches. In a national water scheme, of course, arrangements would be made for impounding the 100 inches, as well as the 20 inches in the several districts. And could the lakes or reservoirs, or some of them, be connected in some way by valves, they might become stores when the rainfall is very great in some other distant locality, so as to prevent the flood waters being lost. Then all local boards, cities, towns, or other authorities, would know where to go for water without having to fight for a water supply, as at present, at an enormous cost, and a supply granted to them on the condition that all localities on the line of their pipes might be supplied on terms to be fixed.

The system of town and other districts having the control and direction of the water supply has been useful in the past. But the circumstances have so altered, by reason of greatly increased populations, fewer districts to select water from, and very much greater scientific knowledge on sanitary subjects being now abroad, it is almost a foregone conclusion that the water supply should be undertaken by the Government for the nation. The following is from the Report of the Royal Commission on Water Supply:—

"Mr. Simon speaks of the great power which water companies hold in regard to the health of the populations supplied by them, and states that he feels very strongly that the public requires more protection than it yet has against their occasional malfeasances." He says:—"This power of life and death in commercial hands is something for which till recently there has been no precedent in the world; and even yet the public seems but slightly awake to its importance.

"255. There are two remarks of a general nature that suggest themselves in regard to provincial supplies. In the first place, it appears to us that the Legislature should always jealously watch any proposal for a town taking water from a gathering ground at a distance from it, lest by so doing it may deprive other places nearer to such gathering ground of their more natural source of supply.

"The argument ought not to be lost sight of in regard to the proposals for supplying London from Wales or Cumberland; for before either of these plans could be approved it ought, we think, to be conclusively shown that the abstraction of water from these sources could not stand in the way of the supply of other places nearer to them. In regard to the lake scheme, this would be, we conceive, a very powerful objection, as that district has already been pointed to as the best source of supply for large and growing masses of population in the north and centre of England. At any rate, when circumstances render it necessary that water should be brought from a distance, care should be taken to include in the scheme the supply of all places along the route by which the water is conveyed.

"256. Then secondly, we would strongly call attention to the remarkable tendency that towns have, in the manufacturing districts, to arrange themselves in groups. Take, for example, the enormous group around Manchester, the group of the Potteries, the group of towns immediately to the north of Birmingham, the groups on the Tyne and near the mouth of the Wear, and many other instances.

"The tendency ought always to be considered as an essential element of any arrangements for water supply. Such a group of towns uniting together may go for a much better and more perfect scheme than any one of them separately, and the Legislature ought not only to encourage, but as far as possible to compel such a combination.

"Referring to the Cumberland Lake district it is obvious that it might be made by a united effort available for providing an almost unlimited supply for great groups of manufacturing towns in the north of England, but it is only by a large union of districts that the expense of such a scheme could be justified."

It will be seen from the above that all these important remarks point to the necessity of having a national supply of water, and that provided by the Government instead of by local bodies.

Millions are now compelled to use very hard water; if the poor are so poor as not to able to buy soap, they must be content to wear dirty clothes, and live in the midst of dirt.

The tea test is most striking, and very many of the poor have to largely exist on tea. Soft water in effect would cheapen it to them very much; and there is no possibility of adequately estimating the saving, if soft instead of hard water could be had for manufacturing purposes, to say nothing of the advantages which would result if it could be had for use as a water power instead of steam, in these days of severe competition.

As there can be no more important question in home legislation than an abundant supply to the population of the United Kingdom of Great Britain of good soft water, we hope that the suggestion of H.R.H the Prince of Wales, and the very great influence of the important body which I have now the honour of addressing, may induce the Government to undertake this good work, without which it is impossible that the best waters can be brought to the doors of the people at a cost much lower than is now being paid for inferior waters. Indeed, it seems extraordinary that so practical a nation should have been so unpractical in this great question of water supply.

H.R.H. the Prince of Wales having drawn the attention of the Council of the Society of Arts to the subject of a national water supply, and having suggested the public good that would arise from an open discussion of the question, it is an almost certain conclusion that so admirable a work taken in hand by his Royal Highness will lead to the accomplishment of a water supply that will secure to the nation at large this article of prime necessity.

W. SHELFORD.

"A large and comprehensive water supply of a national character" must necessarily be considered from two points of view—one administrative, the other constructive—and must involve, on the part of its author, some knowledge of the existing state of things, including the "varying specialities and wants of districts," to which it should be adapted.

Information contributed, therefore, from actual knowledge, may pave the way to a solution of the difficulties, and assist in the elucidation of the subject, by preparing it for the open discussion which has been suggested by his Royal Highness.

The wants of the districts which have come under the observation of the writer are due partly to nature, and partly to art—to nature, where the geological character of the country, its elevation, or depression, and other physical conditions, make good water inaccessible or scarce—to art, where the progress of manufactures, the increase of the population, and other causes have either led to the pollution of the water, or to its diversion or abstraction from its normal channels.

The following examples of want of water due to natural causes, will serve to illustrate the general statement:—

(*a.*) In the chalk districts of the Yorkshire and Lincolnshire wolds, the South Downs, and the large area of chalk which surrounds the outcrop of the London basin, the abundant rainfall is so quickly absorbed that it cannot be collected, and becomes inaccessible from the higher lands, except by means of deep wells, in which the water often stands at a depth of 150 feet, and sometimes much more, from the surface.

(*b.*) In districts covered by clay or other impervious strata, the rain is so little absorbed that it both floods the streams in winter, and leaves them dry in summer, their beds at all times serving as the natural channels for the drainage of the country. Where such districts are elevated much above the sea, there is a great scarcity of water, as, for example, at Farnborough, in Kent, within the London basin, where water is even now sold from a donkey-cart at the price of ½d. per pail.

(*c.*) In the Great Level of the Fens, and similar situations, the surface of the country is very flat and depressed below the level of the sea, and the impervious strata are of such thickness as to preclude the practicability of raising anything but salt water by means of boring.

Of this great district about 450 square miles depend, in dry weather, upon the spare surface water discharged below the town of Peterborough, from a catchment basin of insufficient and of not much greater area.

(*d.*) In certain mineral and rock districts the quality of water is affected by its passage through veins and rocks, and thus becomes charged with deleterious matters in solution.

But whilst the want of good water, due to natural causes, is felt over many hundreds of square miles of this country, it is insignificant in comparison with that which arises from the pollution, misuse, and waste of the greater number of its streams and rivers. This fact is so patent to everyone that it needs no illustration, though the following instances may be mentioned:—

(*e.*) The River Cray, in Kent, which has its origin in a magnificent spring from the chalk, discharging water of the first quality at the rate of 3½ million gallons per day, becomes a sewer within half a mile of its source for the reception of the refuse from paper mills, houses, &c., and the want of good water is such that the Kent Water Company is now laying pipes up the valley, and forcing

the water a distance of five miles, and against an absolute head of 100 feet, in order to supply it.

(*f.*) In clay, and other impervious districts, where the slope of the surface, and its non-absorbent character inevitably result in the flow of all water into the streams, the drainage from houses, manufactories, and manured lands, converts their channels into sewers, and no provision is made either for the passage of the heavy floods or for the conservation of the dry weather flow for domestic use.

Even in agricultural districts good water thus becomes a want which it is difficult to supply, where the impervious strata are thick. As, for example, on the River Ouse, where it traverses the Oxford clay, in Huntingdonshire, exposing such towns as St. Neots to submergence in floods, and not affording them a good source of supply in droughts.

(*g.*) In the Fens, nothwithstanding that they owe their existence to the art of the engineer, the want of good water is increased by the interception of part of the fresh water of the rivers, and the pollution of the whole, to an extent which has led to the supply of the principal towns being effected from distant sources, *e.g.*, Wisbech 18 miles, Spalding 9 miles, Boston 13 miles, while the villages and hamlets are absolutely without potable water, and the want of it for the cattle is so urgent that the stagnant water in the dykes is economised by forcing it back by the admission of salt water at the sea sluices.

(*h.*) The quality of the water in the mineral districts of Cornwall is not only often unfit for domestic use, but is frequently discharged from the mines in a poisonous condition into the streams, and these are further polluted by the washings from the dressing floors of lead and other ores. The town of Truro, through which two considerable rivers discharge themselves into the sea, has thus been compelled to incur the expense of obtaining its supply from an adjoining and separate watershed.

(*i.*) In the manufacturing districts especially, the fouling of the streams is excessive, and the quantity of water consumed is increasing. A competition has arisen for the possession of suitable watersheds by the wealthier towns to the exclusion of those which are unable or unwilling to claim their share. In some cases, an unnecessary area has been secured, with the sanction of Parliament; as, for example, by the town of Preston, which draws its supply from four streams, on only one of which there is a storage reservoir for impounding the floods, while from the other three the whole watershed is laid under contribution for a supply which cannot exceed the minimum dry weather flow, and the remainder runs to waste.

Want of good water is widespread. It is greatest in the smaller towns, villages, and country districts, where the cost of works for a systematic supply would be too great a burden, even if the population were disposed to construct them, for the utilisation of the nearest local source.

The alternative which naturally suggests itself to the mind of an engineer, viz., the creation of one or more great national sources of supply in mountainous and lake districts, supplemented by pumping from the chalk, sandstone, and suitable strata, and distributed through the country by arterial aqueducts, with ramifications by pipes into every village, may be dismissed for the following reasons:—1st. On account of the cost. 2nd. Because of the difficulty of constructing the works to suit the ever "varying specialities and wants of districts." 3rd. Because it has not yet been shown to be either necessary or practicable; and, 4th, by reason of the great difficulty of reconciling such a scheme with the negative policy of the British Government, even if the combination of the various towns having existing works, and the apportionment of the taxation, did not prove to be insuperable.

From a constructive point of view, the aim should be simplicity rather than grandeur. The works should vary according to the locality, its physical resources and conditions, its means and wants, and should be regulated by and subordinate to a well organised administration.

In so far as the water supply of the country is dependent upon streams and rivers (and they are naturally its principal sources), its present want results from the abuse of the streams; but the interests which they serve in the carriage of refuse are too great to admit of the possibility of their complete purification.

Hence the problem for the engineer to solve is how to supply the poorer and more scattered populations, whilst not diminishing the carrying capacity of the streams; or, in other words, how to provide good water without interference with the foul water.

The key to this problem consists in the separation and collection of sufficient good water at its source, and its conveyance by separate channels or conduits along the valleys, so as to restore to the populations one of their most important amenities.

In some instances, the separation of a source of supply would necessitate compensation for abstraction of water power, and for vested interests affected; in others, reservoirs for storage would be required; but the statement may be hazarded that in all cases the works would be of a character which would leave no doubt of their practicability or efficiency. Each valley would derive its supply from its own watershed area—a principle which has been often advocated, and was approved last year by the Select Committee of the House of Lords on Conservancy Boards, and which has this particular merit in reference to water supply—that the majority of the population reside in the valleys, and that the "varying specialities and wants of districts" can be better classified by the valleys in which they are situated than by any other physical features, and can be therefore better provided for.

It is remarkable that, although the Select Committee on Conservancy Boards was appointed to report on the storage of water as well as the prevention of floods, there is no direct reference to the subject in their report, and it may well have been their opinion that the question was simple in comparison with the consideration of the "best means of preserving the channels and outfalls of rivers in such a condition as to suffice for the discharge of the waters flowing into them," which was "one of the principal points to which their attention was directed." That committee did,

however, make the important recommendation that the "rates required to meet the expenses of conservancy should be distributed over the whole area of a watershed," and they were further strongly of "opinion that towns and houses should contribute to the rates in question." If the storage of water, and its delivery along each valley, were to be included in the powers of the Conservancy Boards, it is reasonable to expect that the rates on towns and houses would be more readily paid for the direct benefit, which would be thus derived, than for the proposed occasional relief from inundation.

Nor is it less remarkable that the County Government Bill now before Parliament provides for the conservancy of rivers and for "improving the flow of water therein," but does not otherwise make provision for the conservation of their pure water sources, nor for storage; and this is the more to be regretted because the principle of county government is reconcilable with that which has been so often advocated, viz., a single governing body for each watershed.

An analysis of the rivers, shown upon the Ordnance Survey of England and Wales, made with a view to ascertain whether their catchment basins are generally limited to one or more counties, gave the following results:—

No. of Counties.	No. of Catchment Basins.	Names of Rivers.	Area in square miles.	Area in square miles.
1	158		19,095	
2	31		8,583	
3	15		8,101	
			——	35,779
4	4	Eden, Mersey, Welland, Stour.	3,019	
5	1	Dee	813	
6	1	Nene	1,077	
7	1	Wye	1,609	
8	1	Trent	4,052	
10	1	Ouse	2,607	
11	1	Severn	4,350	
14	1	Thames	4,613	
			——	22,140
	215			57,919

From which it appears that of 215 rivers the catchment basins of 158 are contained in one county, and would come under the jurisdiction of the proposed County Boards, while 31 are in two counties, and 15 in three counties, making a total of 204 rivers in three or a less number of counties, and leaving only 11 rivers in four counties and upwards. These 11 rivers are of sufficient importance to receive special consideration on the part of the Legislature; and, of the remaining 204, 158 are in one county, and 46 come within the scope of that clause in the County Government Bill which provides for the constitution of a joint committee, where two or more adjoining counties intend to avail themselves of its powers.

Here, then, is a possible step in the direction of national water supply, which may be taken immediately, by introducing a few words in the Bill now before Parliament, giving the County Boards such additional powers as will enable them to include in their scheme the necessary works for the collection, storage, and distribution of the fresh water of a river.

The proposed works would not be an innovation, but a restoration of the *status quo ante.*

The operation of the Act would be tentative and gradual, and might have the effect of supplying the wants of some of the unwatered districts of England, whilst on the other hand, the worst consequences of its failure would be that it would remain a dead letter until a better scheme could be carried out.

MISCELLANEOUS.

ON THE PARA AND CEARA RUBBERS, AND BALSAM OF COPAIBA TREES.

A report on the subject of india rubber yielding plants in their own native homes, and comprising also an account of the collecting of balsam of copaiba, has recently been issued from the India-office. It has been furnished to the Secretary of State for India by Mr. Robert Cross, who is well known for his labours in the cinchona forests of South America, and the subsequent introduction of the plants into India, since when Mr. Cross has made more than one trip to South America for the purpose of securing seeds or plants, or both of the best rubber producing trees, and the results of his more recent expedition for this purpose is embodied in the report before alluded to. Mr. Cross gives a brief account of the habits of the Para people, which place he reached on the 15th July, 1876. The population it seems is about 40,000, most of whom are engaged in some way with the despatch of import and export produce. Notwithstanding the reputed fertility of the Amazon valley, nearly all the necessaries of life are imported, butter and fish from Norway, rice and flour from the United States, while sugar, coffee, and mandiocca come from the southern parts of Brazil. The great bulk of the citizens are described as going about more ostentatiously dressed than the people of London; the essential costume being a fine black coat and hat, snow-white vest and trowsers, and fancy French boots. Water is supplied to the city by being carted through it in barrels, and sold at the rate of three-halfpence for about 21 English pints. Dysentery, yellow fever, and various other forms of fever are said to be prevalent, and altogether Para is considered to be more unhealthy than any city in India. The province of Para, and the islands that are scattered over the lower portion of the Amazon, are described as the great field for caoutchouc collecting. A good deal of the rubber from the Rio Negro, Madeira, and other tributaries, seems to come in the form of negro-head or sernamby, while that from the Para region is the finer kind of smoked biscuit rubber, to the preparation of which greater care is given. It is indeed reported that the Para tree is a different variety, its milk leaves no very prominent stain on the hands or clothing, while the milk of some of the varieties of rubber of the upper Amazon gives a black ink-like mark to the hands and clothes of collectors. When once in the country, how Mr. Cross started on his mission will be best described in his own words. He says:—"In order to form and establish a collection of plants, and for the purpose of making the various observations on the soil, climate, and mode of collecting and preparing the rubber, it was necessary to obtain a place to live in while so employed. Everyone told me I would experience great difficulty in finding a dwelling, and this proved true. After travelling round Para and searching for about eight days I succeeded in hiring a house, but at a very high rate, as the place was large, and adapted for a family with attendants and

slaves. However, it was secure, and offered every facility for my various requirements, which was important. My next work was to examine the district where the rubber trees grew, . . . and on the 25th July I made a preliminary journey to the region where the trees were wrought." Leaving Para, the high ground was traversed for several miles until the primitive forest was reached, a path used by caoutchouc collectors through the wood. The traveller soon came upon a large tree in a state of decay, which had been tapped many times. From the ground up to a height of 10 or 12 ft. the trunk was one swollen mass of warty protuberances and knots, covered with thick scales and hard, dry bark. This singular form of growth—the result of the practised system of tapping—has never previously been recorded. A few minutes of careful examination soon showed the real cause of those deformities. The collector uses a small axe-like instrument, an inch broad; at each stroke he cuts through the bark and into the wood for fully an inch. Hundreds of these are made in the trunk of each tree in the course of a few years, and cannot heal under any circumstances; but a layer of wood is formed over the injured part, at the expense of the bark and general vitality of the tree. The newly formed wood is again cut into and splintered, and so the process is repeated on each successive layer, until the trunk becomes merely a mass of twisted wrinkled wood, with very thin insipid bark. In this condition hardly any milk flows from the cuts, and, although for years a few green leaves may continue to sprout from the points of the twigs, yet the tree may be considered as dead, and, in fact, finally withers away. It is, therefore, the injury done to the wood, and not overtapping, which lessens the flow of milk, and ultimately causes the death of the tree. The cuts in the wood are of course unnecessary, since the milk is met with only in the bark. The healing-over process which afterwards takes place is similar to that seen where a branch has been lopped from a trunk. The wood is compact and rather hard, and for this reason the tree lives on for a number of years, although cut and hacked every season; but the flow of milk becomes so lessened that many are practically abandoned for years before they die. This and several large adjoining trees were growing in moist, deep, heavy soil, of a fertile character, but quite out of the reach of any inundation.

On the margins of both the larger and smaller streams a considerable number of rubber trees were found, mixed with cacao and forest trees. Three were observed, the bases of the trunks of which were flooded to a height of one foot, yet the roots seemed to run up to the brow of the bank, and no matted roots were observed, as is the case with the willow tree when growing on the margin of a rivulet. Most of the others occupied dry situations. A number of good plants were met with beneath the oldest trees. At places where the ground was covered by more than two or three inches of water at flood tide, seedlings did not usually grow. By far the greatest number, however, were met with in situations above the reach of the highest tides. A few of the largest trees were measured, all of which had been tapped for periods varying from five to fifteen years. Most of the trees occurring within the limits of the worked districts are tapped if possessing a diameter of six or eight inches. Regularly tapped trees, as a rule, do not exceed 60 feet in height.

Mr. Cross relates some rough and ready experiments made by him with a view of proving the conditions under which the Para rubber plants may be best propagated. These experiments were conducted while the plants which he had previously collected, 2,000 in all, were being established in three cases. He says they were commenced "in order to ascertain how the tree might be readily multiplied in a rough way by any person not specially acquainted with the principles of propagation. Two separate beds, the one of brown sand the other of decayed leaves, were formed. The terminal portion of shoots, but with a bud at the lower end, were planted in the beds in a reclining position with only two inches of the points above ground. Owing to the great distance between the buds, consequent on vigorous growth, many of the cuttings were a foot or more in length. At the same time a number were set deeply in an open vessel containing only rain water. The cuttings in the sand bed were the first to grow, and soon made strong shoots and root fibres. Those in the leaf mould pushed more slowly, but developed green leaflets of great substance. The cuttings placed in the water had a small portion of tap root at the base, as the object was to determine if the roots actually develop in water alone. Within fourteen days these plants had several roots formed, and one or two rather weak growths came up, but a few days after I had thrown into the water some burnt earth and wood ashes the increase in vigour was very apparent. After these experiences I felt convinced that the Para rubber tree delights in abundance of moisture and rich fertile deposits." Mr. Cross gives a very detailed description of the tapping of the trees, the collection of the milk, and the method of preparing the rubber, all facts of great interest, and the more so because information of this kind is not readily procurable in a collected form, being for the most part distributed in various books of travel. On this account Mr. Cross's report should be widely circulated. The fact remains, however, that these reports are not sufficiently known amongst commercial and scientific men, and consequently, the wider diffusion of the heads of Mr. Cross's experience is, perhaps, justified in the columns of this *Journal*. The caoutchouc collectors commence work as soon as daybreak, or as soon as they can see to move about among the trees. They say that the milk flows more freely, or in larger quantities, in the early morning, but little importance is attached to this statement the most probable reason for the early tapping is that, as rain often falls about two or three o'clock in the afternoon, it is necessary that the work should be done early, as, in the event of a shower, the milk would be spattered about and lost. The collector first of all, at the beginning of the dry season, goes round and lays down at the base of each tree a number of small cups of burnt clay. At the lesser trees only three or four are put, but at the larger ones from eight to twelve. The footpaths leading from tree to tree are likewise cleared of sapling growths. On proceeding to his work, the collector takes with him a small axe, for tapping, and a wicker basket, containing a good-sized ball of well-wrought clay. He usually has, likewise, a bag for the waste choppings of rubber, and for what may adhere to the bottoms of the cups. These promiscuous gatherings are termed "sernamby," and form the "negro head" of the English market. The cups are sometimes round, but are more often flat, or slightly concave on one side, so that, with a small portion of clay, they may be easily stuck against the trunk of the tree. The contents of 15 make one English imperial pint. When the collector arrives at a tree, he strikes with his axe in an upward direction as high as he can reach, making a steep, upward, sloping cut across the trunk, which penetrates the bark and an inch or more into the wood, and is often fully an inch in breadth. Frequently, a small portion of bark breaks off from the upper side, and, occasionally, a thin splinter of wood is raised. A cup is next quickly fixed with clay against the trunk, just beneath the cut. The milk, which is of dazzling whiteness, now begins to exude. At a distance of 4 in. or 5 in., but at the same height, another cup is similarly fixed, and then another, until a row of cups encircle the trunk at a height of about 6 ft. from the ground. Tree after tree is treated in this manner until the day's tapping is finished. The earlier the gashing of the trees and the fixing of the cups is done the better, for the milk often continues to exude slowly for three or more hours. The collectors vary very much in the tact and ability shown in the performance of their duties. Some take care to get good clay

previously, and to incorporate it well, so that a very small portion is needed to fix the cups to the trunks; they also work with neatness and intelligence, and invariably collect large quantities of milk. On the other hand, there are some who exercise no forethought in the preparation of their clay, merely scraping up a handful when they need it. This class of collectors often have many fragments of clay and other impurities in their rubber. The quantity of milk that flows from each cut varies. If the tree is large and has not previously been twice tapped, the cups will for the most part be more than half full, and occasionally a few may be quite full, but if the tree is much gnarled from tapping, whether it grows in the rich sludge, by streams, or on dry soil, many of the cups will be found to contain only about a table-spoonful of milk, and sometimes scarcely that. On each succeeding day a similar operation is carried on, with the exception that the cups are placed from six to eight inches lower down, until the ground is reached. The collector thus begins as high as he can reach, and descends as before, taking care however, to make his cuts in distinct places from those previously made. When the produce of milk diminishes in long wrought trees two or three cups are put on various parts of the trunk where the bark is thickest. Although many trees are large, the quantity of milk obtained is surprisingly small. This has been described as the result of over-tapping, but Mr. Cross thinks it is not possible to over-tap a rubber tree, if in the operation the wood is not left bare or injured, but the collector's axe always enters the wood, and the energies of the trees are required to form new layers to cover these numerous wounds. The best milk-yielding tree examined had the marks of twelve rows of cups, all the work of one season. The rows were only six inches apart, and in each row there were six cups, so that the total number of cuts made within the period of three months numbered seventy-two. Though this tree grew in a favourable situation, and was in every respect a healthy tree, it is considered that with about two years of such treatment it would in all probability become permanently injured. There seems to be no appreciable difference in the quality of the rubber, whether collected in the dry or in the rainy season. It may be, however, that in the wet season a larger proportion of water is contained in the caoutchouc, while on the other hand a larger quantity of milk flows. The dry season is, in fact, the most suitable for caoutchouc collecting.

Two other methods of tapping, which are chiefly confined to the Upper Amazon and its tributaries are described, the principles of which are similar to those already explained.

With regard to the collection of the milk from the cups when full, it is done by a man running from tree to tree with a large calabash, into which the contents of the cups are emptied. As he pours the milk out of each cup he draws his thumb or forefinger over the bottom to clean out some which would otherwise adhere, a small quantity, in fact, does remain, which is afterwards pulled off and classed as sernamby. The cups, after being emptied, are laid in little heaps at the base of each tree to be ready for use next morning. The time lost in traversing the intricate muddy footpaths beneath the trees is a serious obstacle to expeditious collecting. More than twice the quantity of caoutchouc might be collected in a fourth of the time, and at far less cost and labour, were plantations properly formed.

To prepare the rubber, the milk is put into a large flat earthen vessel, beside this are placed narrow-necked jars about 18 inches high, and about 12 inches across the broader part; the bottoms are knocked out of these jars, they are raised from the ground on three small stones, fires are lighted in these bottomless jars, and the slight distance they are raised from the ground causes sufficient draft to promote their burning; the fires are fed by dropping pieces of wood and a handful of palm nuts alternately into the mouths of the jars, the aim being to cause a dense smoke to arise from the mouth of the jar. The mould on which the rubber is prepared resembles the paddle of a canoe; in fact, at many places on the Amazon, this is the article most frequently used, if there is much milk, and when the rubber is prepared in bulky masses, a little soft clay is rubbed over the mould to prevent the rubber adhering, and it is afterwards well warmed in the smoke. The operator holds the mould with one hand, while with the other he takes a small cup and pours two or three cups of milk over it. He turns it on edge for a few moments above the dish until the drops fall, then quickly places the flat side two inches above the jar's mouth, and moves it swiftly round so that the current of smoke may be equally distributed. The opposite side of the mould is treated in the same way. The coating of milk upon being held over the smoke immediately assumes a yellowish tinge, and although it appears to be firm, on being touched is found to be soft and juicy, like newly curdled cheese, and throwing off water profusely. When layer after layer has been repeated, and the mass is of sufficient thickness, it is laid down on a board to solidify, and in the morning is cut open along the edge on one side and the mould taken out. Biscuit rubber, when fresh, is often four or five inches thick. After being hung up to dry for a few days it is ready for market. The fact of burning palm seeds (which are said to be those of *Euterpe edulis* and a species of *Attalea*) has given rise to an opinion always stated by travellers that the smoke produced by these burning nuts exercises some peculiar effect upon the milk by which it coagulates almost instantly. After a careful examination of this matter, Mr. Cross expresses it as his conviction that the rapid coagulation of the milk is simply produced by the high temperature of the smoke, and that with a strong current of heated air or a good pressure of steam from a pipe, a similar result would be obtained. He says, "I have no hesitation in giving my opinion that equally as good rubber could be prepared by putting the milk into shallow vessels, and evaporating the watery particles by the heat of boiling water."

With regard to the introduction and propagation of the Para rubber plant into India, the hottest parts and the low-lying, moist tracts, or land subject to inundations are recommended, deep, humid land suitable for cane and coffee planting is quite suited for the tree. The Malay peninsula, Burma, Ceylon, and Southern India are said to possess many suitable localities. The green terminal shoots of succulent growth, with the leaves fully matured, make the best cuttings. They should be cut off low enough to take in a joint at the base. When planting in dry firm land, a spadeful of soil should be turned over at each place, and the cutting planted in a sloping position. It should be covered with mould to within three inches of the point. That portion above ground should rest on the earth on one side to its termination so as not to suffer through hot sunshine. Seeds may also be planted and the soil much improved by the addition of a handful of wood ashes with each seed at the time of sowing. In watery places, or in deep mud deposits, seeds are not recommended, as many would mould and rot. Mr. Cross gives a very detailed description of the best modes of propagation, soil, &c., and also his experience in search of the Ceara rubber, about which a good deal of interest has been manifested, the plant producing it not having been accurately known, but suspected by many writers to be identical with the Para tree. Mr. Cross succeeded in bringing home seeds and plants, and the true Ceara rubber is now proved to be the produce of *Manihot glaziovii*, which, though quite distinct from that of Para, nevertheless belongs to the same natural family—the Euphorbiaceae. The rubber is collected in a different manner to that of Para. The outer surface of the bark of the trunk is pared off to a height of four or five feet, the milk then exudes and trickles down in an irregular manner, falling, for the most part, on to large leaves

that are laid about the base of the trunk to receive it; some, however, drops on to the ground, and so often gathers up with it dust and loose stones. After several days the juice becomes dry and solid, and is then pulled off and rolled up into balls or put into bags in loose masses. The trees are badly used, the tapping being made too deeply into the wood, so that many trees are in a state of decay. From the fact that Ceara rubber occupies a good place in the market, being exported at the rate of about 1,000 tons per annum, it is to be hoped that more care may be taken of the trees, and that it may be successfully established in India. Mr. Cross suggests that in the districts of Madras, Cochin, Calicut, Cannanore, Mangalore, and Bombay, many localities possessing all the conditions essential for the growth of Ceara rubber may be found, and the plant might also be tried in the deep tropical valleys of Assam; indeed, in all the parched regions of India within the limits of coffee culture.

On the subject of balsam of copaiba, which is yielded by different species of *Copaifera*, Mr. Cross describes them as having a wide distribution, being abundant in the forests of the Amazon valley, of Guiana and Venezuela, and in the wooded littoral districts of New Grenada, especially in the States of Santa Martha, Carthagena, and Panama. The finest sort known in commerce, and called by the collectors white copaiba, is met with in the province of Para, and is shipped from Para and Maranham. Very large quantities are annually sent to the French market. Formerly, the trees might be seen growing within easy access; but, owing to the method of collection practised, it is now comparatively rare. At present, a collector must make a journey of several weeks in a canoe up some of the Amazon tributaries, or penetrate into the dense forest lying between the rivers, to find any considerable quantity of copaiba. The life of a balsam collector is said to be one of the most wretched description, as he is exposed daily to the drenching rains in the depths of the forest, with often an insufficiency of food, constantly bitten by large, formidable ants, and tormented unceasingly by day and night by swarms of mosquitoes. As if to make amends for all these miseries, a collector can earn, when the trees are abundant, as much as £5 per day. The trees grow to a great height, running up to 50 ft. or 60 ft. before branching, but no seedlings, or young plants, are to be found in the forests, for so soon as the seeds fall they are greedily devoured by a small animal about the size of a rat. To collect the balsam a hole or chamber, about a foot square, is cut in the trunk, at about 2 ft. from the ground. The wood is white to a depth of 4 in. or 5 in., after which it is of a purplish red colour; indeed, the woods of all the species of copaifera have this peculiar tint. When the centre of the tree is reached by the axe, the balsam flows out in a current full of hundreds of little white pearly bubbles. "At times, the flow stopped for several minutes, when a singular gurgling noise was heard, after which followed a rush of balsam. When coming most abundantly, a pint jug would have been filled in the space of one minute." From the fact that every chip cut out was studded with drops of balsam, it seems conclusive that every particle of the wood is highly charged with it, though the bark appears to possess none. A large tree, in good condition, is estimated to yield about 84 English imperial pints. Mr. Cross refutes the stories told by travellers, that the balsam is collected by gashing the bark, and plugging the space with cotton to absorb the juice which exudes, or that of closing cavities, made in the trunk, with clay or wax, to allow the balsam to accumulate, and then opening them and extracting the collected balsam. Both systems, he considers, would be practically useless. Little or no care seems to be taken to preserve the balsam pure. Old jars and barrels, that have previously contained grease or liquors of all descriptions, and old paraffin cans, are very much sought after, and are used without being properly cleaned.

This valuable tree, like those yielding india-rubber, has been proposed for introduction to India. The temperature required for it is similar to that required for the Para rubber tree. Wet or moist land should be avoided, and the plants should be put in the best dry loam such as is suitable for cane or coffee planting; seedlings may be planted tolerably thick so as to shoot up rapidly, when they could be thinned out to proper distances. Mr. Cross concludes his remarks on this interesting tree in the following words:—"I would not recommend the planting of these trees on a large scale with a view to early profit, as the growth would be slower than Panama or Para rubber trees. The return would, I think, be realised in about the same time as is the case with oak plantations. However, a few hundred of copaiba trees growing on a planter's estate ought to enhance the value of it. Apart from the medicinal value of copaiba, it might be well to ascertain if it would not be equal to castor oil for lubricating machinery."

POLLUTION OF RIVERS.

At the last meeting, on the 3rd July, of the Sanitary Institute of Great Britain, the Duke of Northumberland in his opening address dwelt upon the evils of river pollution, not only in the danger arising to the people directly, but also in the loss of fish food. Mr. Frank Buckland delivered an address upon the "Pollution of Rivers, and its effect upon the Fisheries and the Supply of Water to Towns and Villages." He earnestly commended to the attention of his hearers the importance of care being exercised over every source of the food supply for these islands. While we were becoming more and more dependent upon foreign sources for the supply of food, we were diminishing, by means capable of speedy and beneficial remedy, the splendid supply of food afforded by our rivers and coasts. Not only did the pollutions of the rivers rob us of a very large part of this supply, but the towns were robbed of the water needed for the inhabitants, and were obliged to fetch from afar, at enormous expense, that which, but for pollution, they could obtain at their own doors. He proceeded to speak of the fish destruction by these pollutions, and stated that the great salmon fish farms are divided into 41 districts, and he gave a list of the various pollutions from which these river unfortunately suffer:—The Axe, from sewage; the Camel, from china clay and mines; the Dart, from chemicals, mines, paperworks, and wool washings; the Dee, from oil and alkali works, petroleum, paperworks, and wool washings; the Dovey, from mines; the Ellen, from coal washings, tan, and mines; the Eden, from sewage, tan, and mines; the Exe, from sewage and paperworks; the Fowey, from china clay works and mines; the Kent, from manufactures; the Lune, from paperworks; the Medway, from manufactures; the Ogmore, from coal, tan, and sewage; the Ribble, from sewage, factories, and chemicals; the Rhymney, ruined by pollutions; the Severn, from sewage, mines, tin, and dye-works; the Stour, Canterbury, from sewage; the Tamar and Plym, from mines and clay-works; the Taw and Torridge, from sewage; the Tees, from mines and sewage; the Teify, from *débris* from slate quarries and mines; the Teign, from mines; the Towy, from mines and chemicals; the Trent, from sewage and factories; the Tyne, from chemicals, mines, and coal-washings; the Usk, from tin-plate works, ironworks, lime, ashes, coal-washings, and sewage; the Wear, ruined by mines; the Yorkshire rivers, from tan, lime, factories, and sewage. Thus it would be seen that the best salmon rivers in England and Wales were nearly all suffering from pollutions of some kind or other, generally mines at the top, and chemicals, paperworks, and other factories, sewage, &c., from the towns through which they flowed, it was no longer to be tolerated that the Thames

should be polluted by the towns above London, and he declared that all sewage should be kept from the upper parts of the Thames and its tributaries, for the tolerance of such pollution endangered the health of the people. It was most lamentable to think that at the present time, when there were so many mouths to be fed, manufacturers and mine owners, who form a relatively small proportion of her Majesty's subjects, should be allowed to inflict directly and indirectly such a vast evil on the public in general. These individuals and companies for the most part reaped no inconsiderable profits from their industrial operations, but while endeavouring to increase their own profits they treated with indifference the welfare of the public, and an important source of food not only to themselves, but to the public in general. He did not wish, for the sake of the fish in the rivers, by any means to put down or in any way interfere with the commercial industries, either of manufactories or mines, in this country, but at the same time it was quite possible that both industries could co-exist and flourish together side by side.

GENERAL NOTES.

Automatic Extinction of Fires in Theatres and other Buildings.—An invention has been patented by Messrs. Lawes and McLennan to extinguish automatically fires in theatres and other buildings. By the application of the invention, it is intended that fire shall itself be the means of introducing water in such a manner as to shut out air from the flames, and so deprive the fire of oxygen. To effect this, perforated tubes of any size or shape suitable to the building or room to be protected are permanently fixed in convenient places, and where rendered desirable from the extent of the area to be protected, the tubes are divided into sections of any length. The tubes or sections are connected by pipes with the water-main in the street, or with a cistern placed over the building. The connecting pipes are each provided with a cock and lever, and when the latter rests at right angles to the pipe, the cock is closed, and the water is thereby shut off. The lever is kept in position by means of cord, which, in the case of a theatre, extends across the flies and wings. On the occurrence of a fire, as soon as the cord burns and breaks, the lever, from its own weight, falls, and, opening the cock, the water ascends into the perforated tube, or section, commanding the area on fire, and the position of the perforations are intended to direct the water in such a manner as to cover, in falling, the whole surface on fire, to the exclusion of air.

Alfa and Ramie Fibre in Algeria.—Consul-General Playfair, in his last report on the trade and commerce of Algiers, states that the traffic in Alfa continues to increase, several establishments being in course of erection for reducing it to pulp on the spot, thus saving carriage and freight. The largest quantity of Alfa is gathered in the subdivisions of Sidi-bel-Abbes and Mascara, and almost the whole of it is shipped at Oran. The latest return (namely, that for 1876) shows that 58,759 tons were exported in that year to England, France, Spain, Portugal, and Belgium. The Ramie plant (*Bœhmeria nivea*) promises to become one of the staple products of the country. The experiments made with it in the province of Oran, especially near Relizane, and in the plain of the Habra, have been satisfactory.

Healthy Houses.—The *Lancet* says the Manchester and Salford Sanitary Association, taking example apparently from the movement in Edinburgh, has made arrangements for a sanitary inspection department, with the object of providing for the members, at a moderate cost, such advice and supervision as may ensure the proper sanitary condition of their own dwellings; and further, may enable members to procure practical advice, on moderate terms, as to the best means of remedying defects in houses of the poorer classes, and any other premises in which they are interested. Persons may become members of the department upon payment of an annual subscription of £1 1s., occupiers of houses of ove £50 and under £100 rental being required to pay £1 1s. extra, and occupiers of houses of £100 and upwards £2 2s. for the first year, The society proposes to appoint one or more sanitary engineers for the purpose of inspection and reporting, and to have inspected the premises of members, with a report prepared thereon, once yearly, in addition to promoting the general sanitary advantages which have been stated.

Suez Canal.—The number of ships which passed through the canal in the first four months of this year was 620, as compared with 613 in the corresponding period of 1877, and 576 in the corresponding period of 1876. The transit revenue collected by the Suez Canal Company in the same period amounted to £464,876, as compared with £486,388, and £451,200 in the corresponding periods of 1877 and 1876.

THE LIBRARY.

The following works have been presented to the Library:—

Central America, the West Indies and South America. Edited and extended by H. W Bates, Assistant-Secretary of the Royal Geographical Society, with Ethnological Appendix by A. H. Keane, B.A. (London: Edward Stanford, 1878.) Presented by the Publisher.

The Journal of the Royal Geographical Society, Vol. 47, 1877. Edited by the Assistant-Secretary. (London: John Murray.) Presented by the Society.

Minutes of Proceedings of the Institution of Civil Engineers. Vol. 52. Session 1877-8. Part 2. Edited by James Forrest. (London: Published by the Institution, 1878.) Presented by the Institution.

Society of Engineers: Transactions for 1877. Edited by P. F. Nursey. (London: E. and F. N. Spon, 1878.) Presented by the Society.

Geometry in Modern Life, being the Substance of Two Lectures on Useful Geometry, given before the Literary Society at Eton. By J. Scott Russell, F.R.S. (Eton: Williams and Son, 1878.) Presented by the Author.

A Concise History of France, with Notes, and a Complete Vocabulary, suitable as a First French Reader. By G. C. Mast. (London: W. Stewart and Co.) Presented by the Author.

French: Practice and Theory, or a New Practical and Natural Method of Learning to Speak and Write the French Language. By G. C. Mast. In Two Parts. Part 1. (London: Charles Bean, 1873.) Presented by the Author.

The following pamphlets have also been presented:—

The Correction of Clocks by Hourly Currents of Electricity. By Frederick J. Ritchie. (Edinburgh: Neill and Co., 1878.) Presented by the Author.

Electro-Sympathetic Clocks and Time-Signals. By F. J. Ritchie. (Edinburgh: Neill and Co., 1873.) Presented by the Author.

Proposals for a System of Technical Education. A Report to a Committee of the Livery Companies of London. By H. Trueman Wood, B.A. (London: Printed for private circulation, 1877.) Presented by the Author.

ERRATUM.

In some of the *Journals* published last week several paragraphs in Mr. Edwin Chadwick's paper on National Water Supply were, by a printer's error, transposed. As soon as the mistake was discovered it was rectified, but in the meantime many of the *Journals* had been issued. Members wishing for a corrected copy of that number can obtain one on application to the Secretary.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,339. Vol. XXVI.

FRIDAY, JULY 19, 1878.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE APPLICATION OF PHOTOGRAPHY TO THE PRODUCTION OF PRINTING SURFACES AND PICTURES IN PIGMENT.

By Thomas Bolas, Esq., F.C.S.

Lecture I.—Delivered February 18th, 1878.

Photo-Lithography and Photo-Zincography.

When a photographer wishes to take a picture, he, as a rule, begins by making what is technically known as a negative; this being a transparent picture having the lights and shades reversed. Now, here is a negative; as I hold it before the lime-light you see that the parts corresponding to the dark portions of the original are transparent, and those parts which correspond to the lights of the original are opaque. Here, on the other hand, is a positive, or transparency, of the same subject as the negative which you have just seen; the lights and shades of this being as those of the object represented. A negative taken from nature should show the reverse of all those gradations of light and shade which characterise natural objects, while a negative taken from a line engraving or a page of letter-press should show only two gradations, complete opacity and clear transparentness. Here is such a negative; and notwithstanding the fact that the opaque parts are not quite opaque to the sight, they are chemically opaque, that is to say, they will not allow the photographic rays to pass through. I have nothing to say to you regarding the making of negatives, as this matter belongs to photography proper, and not to our present subject.

Here is a sheet of paper which has been so prepared as to become darkened on exposure to light; let us place this behind our negative, and allow the light of burning magnesium to shine on the face of the negative. You see the result. Those parts of the paper which were covered by the transparent parts of the negative have become dark, while those parts which were protected from the light by the opaque parts of the negative retain their original white colour. Thus a positive print is obtained on paper; but if the paper print be now exposed to daylight the whole will become dark, the picture, consequently, disappearing.

This operation illustrates the first phase in the process of photographic printing as usually practised, the next step being that of unsensitising the paper, so as to prevent the complete darkening which would otherwise ensue on the further exposure of the print to light. Our object now is to study the means of producing printing surfaces (plates or blocks) from which copies can be printed without the direct action of light being concerned in the production of each print.

The piece of paper which I now hold in my hand is sensitive to light, and I will place it under this negative of a line drawing, and expose to the action of an intense light. You observe that a very faint brown image is now produced on the sensitive paper by the action of the light shining through the transparent parts of the negative; and I now hide this from your view by covering the face of the paper with a thin and uniform layer of printer's ink. For this purpose the ink is diluted with a little oil of turpentine, and applied by means of a dabber, made of the glue and treacle composition which typographic printers use for making ink-rollers. The oil of turpentine soon evaporates, and leaves a compact and thin film of printer's ink on the paper. I next put the inked print into water, and leave it there while I tell you how the sensitive paper was prepared. A sheet of plain paper is first floated on this warm solution of gelatine (containing six per cent. of gelatine), and it is then hung up to dry (as I do now). When dry it is insensitive to light, and it may be kept any length of time without injury. To make it sensitive to light it is soaked for a few minutes in this solution of potassium bichromate, which contains about $3\frac{1}{2}$ per cent. of the salt, and it is once more hung up to dry, but this time in a dark room, or in a room illuminated by yellow light. When dry, it is ready for exposure under the negative.

Let us now return to the inked print which we left soaking in water, and try the effect of gently brushing the inked surface with a wet camel's-hair brush. You see that the ink is gradually coming off, but in order to save time let us employ a little warm water, and, at the same time, continue to use the brush. Now the end of the matter is, that the printers' ink becomes removed from all those parts of the paper which were not exposed to the action of light, and an image in fatty ink is thus obtained on the gelatinised paper. From this I now remove the excess of water by means of blotting paper, and lay the print, inked face downwards, on a clean and slightly warm lithographic stone. The stone and paper being now passed through the press, you see that the paper adheres firmly to it, but on moistening the paper with a sponge it becomes easily removable. Now I strip it off, and you see that the fatty ink is fixed on the surface of the stone, leaving a perfect but reversed image thereon. Remember that this image consists of fatty printers' ink, and that it penetrates a short distance into the porous stone. Next, I put some thick gum water on the stone, and this also penetrates a short distance into those parts of the stone not already covered with printers' ink. I now rinse off the excess of gum and apply the inking roller; you see that the ink only adheres to those parts already inked, the gummed parts resist the ink, and consequently remain white. A sheet of paper being now laid on the stone, I now pass the stone and paper through the press, and you see that I get an exact counterpart of the original fatty image (technically called a transfer) which

was put down on the stone. Numerous copies may be printed from the stone by repeating the damping and inking.

You will recollect that when the light brown image was inked with printers' ink, the ink covered the whole face of the paper; but when this inked image was put into water, the ink became easily removable from the unexposed parts. Now, gelatine which contains potassium bichromate, undergoes a remarkable change when exposed to the action of light. It not only becomes brown in colour, but it loses its property of swelling in water, and, at the same time, it refuses to be moistened; in fact, water rolls off it just as from a duck's back. Now, when the inked print (transfer) is put into water, the unexposed parts of the bichromated gelatine swell, and loosen their hold on the fatty ink, while the exposed parts neither swell nor absorb water, but hold the ink firmly. In this dish are some uninked transfers, which have been soaked in water, and if you examine them closely, you will be able to trace those parts of the gelatine which have swelled, leaving, in each case, a delicate *intaglio* image, or representation, of the negative employed.

Instead of putting the photo-lithographic transfer down on a lithographic stone, it may be put down on a zinc plate, and the plate can be printed from, if treated exactly as the stone was treated. There are on the table some zinc plates and stones, with images transferred thereon, together with proofs from them; and there are also specimens illustrating the various phases of photolithography and zincography. Messrs. Whiteman and Bass, who have been most successful in the commercial practice of photolithography, have kindly lent me some very fine specimens of their work, which I am sure you will examine with much interest. There are also on the table some admirable specimens of work by Mr. Maurice Adams.

You understand that, in its usual form, photolithography is only adapted for the reproduction of line subjects, or subjects in extreme black and white, and various attempts have been made to render it available for the reproduction of the gradations of a negative taken from nature. By a modification of Asser's starch process I have been enabled to get results which are at least encouraging. Here is a sheet of blotting paper, which I now cover with ordinary flour paste, containing 8 per cent. of flour. The paper having been coated, it is next smoothed with a soft badger brush, just as I am doing now, and when dry the paper is soaked in a $3\frac{1}{2}$ per cent. solution of potassium bichromate, in order to make it sensitive to light. This piece of the sensitive paper being placed under a negative, and exposed to the light of burning magnesium for a few minutes, soon becomes tinted with a brown colour where acted on by light, as you see. The light brown print is next soaked in cold water, in order to remove the unaltered portion of the potassium bichromate, after which it is dried and ironed with a warm flat-iron, just as I am ironing this one. This last operation is to harden the coating. I now put the ironed print into water, take it out, lay it on blotting paper, and dab on printers' ink with a stiff brush. You see that the ink adheres to those parts where the bichromated paste has been made insoluble by the action of light, and it refuses to adhere to those parts where the paste remained unaltered. In this way a fatty transfer is obtained which, as you see by these examples, shows all gradations of a negative taken from nature, not, however, as a true half-tone, but as a grain or stipple well adapted for transferring to stone or zinc. As a fine image of this kind is liable to get clogged up when printed from stone, it is better to transfer it to a plate of zinc, and to make a typographic block from this by the method which I shall describe in a subsequent lecture. In the interval I will convert this zinc plate into a typographic block, and you will be able to compare these proofs, printed by the lithographic method, with others which I will take from the typographic block.

I hope some of you will experiment on Asser's process, with the view of improving it, as this method affords a promising field for work, it being specially adapted for large pictures.

NATIONAL WATER SUPPLY.

The following are some of the communications brought before the Congress, held on the 21st and 22nd May:—

JOSEPH PRESTWICH, F.R.S., Professor of Geology in the University of Oxford.

In accordance with the circular of the Society, enclosing copy of letter of his Royal Highness, I beg to submit the following observations on the several natural water resources of England, more especially with regard to the geological character of the water-bearing strata, whether as affecting the volume of supply or favouring the injury from organic contamination of our underground waters.

The water supply, as it now exists, whether of detached houses, villages, or towns, has been one of purely local growth, and although the sites of most of our older villages and towns have been determined by the presence of an easily accessible water supply, such as may be obtained by shallow wells or from rivers, very little improvement, and that only in the case of our larger towns, has been introduced in the sources of supply, notwithstanding that in the mode of distribution of the supplies in large towns, England has distanced all other countries. With the increase of population, the simple contrivances that were originally in use have otherwise in most cases experienced but little change, although our buildings may have become crowded upon one another to an inconvenient extent, and have produced evils of the most serious character. Water-bearing strata—whether consisting of beds of Gravel overlying clays, such as the gravel on which London stands, or of the outcropping beds of a deep-seated formation such as the Lower Tertiary sands under the London clay, or of hills of permeable strata such as the Chalk or Oolite ranges—while they absorb and store the rain water which they deliver again in the form of springs, absorb with equal readiness water from any other sources—consequently, what apparently more convenient in constructing a house than to sink a well in one part of the premises for water, and on another part for the house sewage. The works are

out of sight; no one thinks of the evil, and few realise it if they see it. But the evil is an accumulative one, and every now and then we are reminded of its existence by disastrous and fatal results. It has grown to such an extent, that almost all the shallower of these sources of water supply are contaminated and injured, and our villages and smaller towns are suffering to an extent which it is difficult to estimate, and which few probably, except geologists, can fully realise. Not but that the other sources of supply—our rivers—have been treated with equal disregard of sanitary principles, and they would, but for timely Parliamentary interference, have suffered equally in consequence. The able sixth report of the Rivers Pollution Commission illustrates in a remarkable manner the consequence of this neglect, whether in the case of our wells or of our rivers.

I have prefaced my communication with these few remarks, because in considering the general question of water supply, it is as indispensable to determine what source should be avoided, as it is to see what sources are available, and in what way the mistakes of the past may be avoided for the future. Fortunately, natural agencies are constantly operating to counteract the evil consequences of our neglect. The power of oxidation and absorption of the soil on underground waters, and of air and light on surface waters, goes far to remedy the evil and restore our springs and rivers to their original purity. The surface waters have been the subject of successful legislative enactment, and it is to be hoped that some similar measure may be applied to our underground waters, for nothing else it seems to me can effect a cure for an evil which is so wide-spread, and at the same time so entirely withdrawn from observation. The arrangements being all below ground, are unknown in most instances to all except the builder, and the well-springs, although often seriously contaminated, yield too often water which is so cool, limpid, and sparkling, as to not only give confidence to the resident, but even to inspire him with a belief in its unusual excellence.

In our larger towns, where cesspits are gradually being done away with, the wells may improve if no other source of impurity exists, but in villages and detached houses, where nothing is done, not only do the local underground springs suffer, but it is to be feared the pollution often injures sources having a wider range. Some contrivance for the protection against the contamination of underground waters, used in common by adjacent communities, is as much needed as party walls are, as a protection against the spread of one's neighbour's fires.

If this were done, many of the underground springs which of old supplied both town and rural population, might be again rendered available for their use, and it would not be necessary to look for a supply to more distant and less accessible sources. It must be, however, remembered that none of our several sources of public supply are free from some drawbacks.

The gravitation system is very good where there are large tracts of high ground not under cultivation, but with the decrease of these and the increase of population the difficulties in the use of this plan are yearly increasing. The variability of our rainfall forms also an objection.

Rivers offer a source generally available, as their waters consist of the immediate rainfall, flowing at once from the impermeable portions of each hydrographical basin, and of the springs due to past rainfalls, discharged in the same basin, throughout longer periods of time, from the permeable strata—but for the many contaminations to which they have too frequently been subjected. With the remedies, however, now in operation against river pollution, and the well-known purifying effects of flow and aëration, our rivers still frequently offer convenient and large sources of supply.

Springs afford supplies, generally good in quality, but more limited in quantity. Instead of being absorbed in our rivers, the risks incurred in their channels are avoided when the springs can be at once diverted and stored for use. Where they are sufficient, there cannot be a better source.

Deep wells may be either ordinary ones—sunk in an area where the permeable strata extend from the surface to considerable depths, as in the case of our chalk downs or oolite hills—or may be Artesian wells, when the same permeable strata pass beneath impermeable strata, and can only be reached by passing through the latter, when the water rises in the bore, or shaft, to its natural level, which may be above the surface or may be at some depth intermediate between the surface and the imprisoned spring; in any case, it may be assumed to rise to a considerable height above its original level.

An impression prevails that, owing to the extent of filtration experienced by the surface waters in passing through a great thickness of such permeable strata, it becomes purified more effectually than it can be by any other means. To a certain extent this is true, but these strata are, nevertheless, exposed to the same dangers as are the river waters, only the sources of contamination fail to make themselves so apparent, nor do they exist to the same amount. They are, nevertheless, there, although from being less conspicuous, they have not attracted so much attention. Thus, in constructing a house on the sand hills of Sussex or the chalk hills of Kent or Surrey, it is the almost invariable practice to dig a shaft more or less deep into which the house sewage and surface waters are directed, and from which they disperse rapidly and disappear in the mass of permeable strata, as in a filter. Neither builder nor tenant may know or inquire what becomes of all this fluid refuse. But it is of course not lost. It passes underground, and goes to increase the reservoir of underground water stored away in the body of the hills. The population on these hills is, owing to the depth at which the water lies, usually sparse and scanty, so that the evil is at its minimum. Still it exists, and is increasing, while manufactories, cemeteries, and increasing cultivation, contribute their inevitable quota. It is not difficult, therefore, to account for the presence of nitrites and nitrates found in our chalk and oolite waters, although it must be at the same time observed, that the extent of filtration breaks up and destroys almost all the original organic matter. Yet so it is in our rivers where the flow (as in the other case the filtration) is of sufficient length.

But there is another and more serious evil to guard against in some underground waters, and this is the consequences to be feared from blind wells communicating with the springs. These wells are formed where the underground spring does not rise to the surface, but stands at a depth of 50, or 100, or more feet. Then any addition made to the spring does not affect the level, or only temporarily, of the water in the well, but goes to feed the volume of the spring. This may go on for years, the impure water passing below ground, and forming a constituent part of the spring. Such wells form natural drains of a most permanent kind; because, as the underground spring cannot rise in the well so long as the other channels of escape by which its surplus waters have been hitherto discharged remain open, every addition to it only increases the volume of the spring. This plan was formerly so largely adopted in Paris, that the waters of many wells there were rendered entirely unfit for use. It is to be feared that London and its neighbourhood are not free from them. Those with whom it originates are, I imagine, often not aware of the consequences. I have not made this the subject of any special inquiry; but looking at the facilities this plan offers for ready and inexpensive drainage, I have reason to believe that these blind wells may not be uncommon, whether in the chalk or in the lower tertiary sands under the London clay. Incidentally, two cases have come to my knowledge which will serve as illustrations.

Some time ago, it was in contemplation to construct such a dry well for drainage purposes a few miles from London. I happened to be consulted and pointed out the objections, but whether or not the work was carried out, I do not know. The other case is, if rightly reported, a most objectionable one. A cemetery near London stands on a bed of gravel; under the gravel is the London clay, and beneath the London clay are the water-bearing Lower Tertiary sands which hold the springs supplying the greater number of artesian wells in London. I am informed, that in order to carry off the water from the gravel in which the graves are dug, a dry or blind well was sunk through the London clay into the underlying sands, and that into this well the drainage of the cemetery is diverted. Although the filtration through the sands will remove much, or, if the distance be sufficient, possibly all of the organic matter carried in by such refuse waters, still such a proceeding cannot be otherwise than most objectionable and obnoxious, and serves to show how our wells may be polluted as clearly as in the instances of the more conspicuous pollution of our rivers.

In fact, with our present arrangements, and with the distribution of our population, the purity of our water sources is only a question of degree. Although nature steps in and is incessantly at work in remedying rapidly and effectually much of the evil, there are limits to this self-acting process, and while, on the one hand, the fixity of the rainfall ensures that the measure of our future will not exceed those of the present sources, the calls on those sources must steadily increase, and if care be not taken, there will, with the increase of population, be a proportionate increase of contamination. But this care, for the reasons before mentioned, cannot be exercised by individual action. Self-interest and incompetency are alike opposed to any such expectation. It can only be done by legislative measures, of which we have had a commencement in the Rivers Pollution Bill. Some similar measure of protection is equally needed for our underground waters and our springs.

Let us now briefly consider how our sources of water supply are derived. There is the rainfall stored in lakes; there is the rainfall stored in hills and at depths beneath the surface; and there is the rainfall carried off by rivers and coming to the surface again as springs from the overcharged hills.

Lakes.—In imitation of these natural reservoirs we have the artificial reservoirs of drainage areas to which we have before alluded. The objections which apply to the latter, do not, however, apply to the former. Lakes in this country only exist when the rainfall is exceptionally great, when the land is high, the rocks hard, and in great part bare, and where the population is scanty and never likely to be very numerous. Such districts, therefore, possess large, steady, and pure water stores, vastly in excess of the needs of the local population, and offer to the teeming populations of adjacent lower lying districts, the most valuable boon of their surplus stores. I consider, therefore, that in a national point of view, for the supply of our manufacturing and large commercial towns, where the population has outrun from its numbers, or overrun with its impurities, the ordinary supplies of the hydrographical basin in which they are situated, the waters of these lakes, if fairly and economically used, and with due local considerations, present legitimate and most valuable sources of water supply.

Wells.—Another source of supply lies in the water stored in our hills, and at depths beneath our valleys. The annual surplus escapes as springs, to which I will refer presently. That which remains underground is obtained either by deep and artesian wells, or by shallow wells. The deep wells are especially valuable in Chalk, Oolitic or Triassic districts, where the mass of the strata is great, and the water stores proportionately large, and in those districts of England where these formations exist, they may often afford excellent sources of supply, though care is required, that as far as possible only the waste and surplus quantity is taken, as otherwise the neighbouring springs and wells must unavoidably suffer.

Artesian Wells can often be used with great advantage. As the outcrop of the strata supplying them is sometimes at a very considerable distance from the towns they supply, they may conduct water from districts where it can be spared to others where there is a deficiency. At the same time, the extent of strata through which the underground water passes, and the depth beneath the surface, ensure the most perfect filtration and uniformity of temperature. The Chalk where it extends under London acts in this way. But as the water does not pass with great facility, and the drain on it is excessive, the level of the underground water diminishes, as is well known, from year to year, and stands now many feet below its normal level. In such a case as this there is a risk to the quality of the water, for under

the original normal conditions the surplus underground water due to the annual rainfall escapes through various channels at the lowest levels, especially in beds of rivers or the sea shore; but when the water line falls, through artificial interference, beneath these surface levels, the pressure is reversed, and an inflow is established which inevitably carries in the outer waters (before the receiving medium) to supply the deficiency, and if those waters be impure, the springs must suffer. In all these cases, the original natural balance cannot be disturbed without introducing complications which are difficult to foresee.

The Oolites and the Triassic rocks of the midland counties, where they pass under impermeable strata, also lend themselves to the formation of Artesian wells, as do likewise beds of sand when sufficiently thick. On a small scale, the Lower Tertiary sands have for some years past been made available for this purpose; but their dimensions are very limited, and the demand on them too large. There exists, however, at greater depths beneath the Chalk, the Lower Greensand, which, as I have long pointed out,* would in all probability, as it does at Paris, be found to contain large stores of water. There is, however, the possible contingency of iron being present; for although most of the Greensand water, both in wells† and at its outcrop, is of excellent quality, there are other wells where the water is slightly ferruginous. This can only be determined by experiment. The anticipation first formed of the continuation underground of the Lower Greensand from Kent and Surrey to Buckinghamshire, proved incorrect, as it was found to be interrupted by an underground ridge of Palæozoic rocks. But the boring recently made at Messrs. Meux & Co.'s brewery has shown this formation to extend northward as far as that point, so that in the area between south London and the Chalk hills of Kent and Surrey, the Greensand, which varies between these points from 60 to 500 feet thick, would, no doubt, be found in sufficient development to yield a large quantity of water, and might prove to be a source of considerable value for public metropolitan purposes. But whatever the quantity, both quantity and quality must inevitably suffer if the source be open to unrestricted use. For whether with the waters stored in our hills or at depths beneath the surface, it must be borne in mind that all the surplus quantity (which is that due to the annual rainfall) escapes naturally in the form of surface springs, except the very small proportion that escapes below the high water mark, in our estuaries, and on our shores, where the permeable strata run out to sea. At a distance from the coast this action is reduced to a vanishing point. How far, therefore, these underground waters can be drawn on without injury, depends on local conditions of population, surplus quantities, &c., which must be determined separately for each case, but it is necessary to observe that while you may depend on the quantity yielded by the annual rain-supply, you can no more overdraw the water-capital of these hills without a resulting deficiency in the course of years, than you could expect to maintain income while drawing annually on capital. Both must end in bankruptcy.

* "The Water-bearing Strata around London."—Van Voorst.

† The two deep artesian wells at Paris yield water of great purity, and valuable as an auxiliary source of supply.

I have already mentioned that these sources of supply are not, any more than rivers, altogether free from pollution, but the extent of filtration, where the permeable strata are thick, as in the Chalk, the Lower Greensand, the Oolites, and Trias, reduces the mischief to its minimum. It becomes more objectionable when the strata pass at depths beneath the surface, and the water can only escape by artificial means, and, therefore, in much smaller quantities. Still, as a rule, these waters are good and wholesome, and where the underground reservoirs are so extensive that their use does not interfere with local supplies, or with the permanence of streams, they offer convenient sources of supply, which, if moderate in quantity compared to lakes and rivers, are often available when the latter are not.

Shallow Wells, 10 to 20 feet deep, are very general in thin permeable strata overlying beds of clay. These, from their small dimensions, contain only limited quantities of water, and are affected, therefore, by a less quantity of impure admixture. But from the circumstance of being of easy attainment, inexpensive, and at every door, they are in more general use than any other source for private supply, where the quantity of water required for each house is small. For the same reason such sites were early selected, and have been in use for ages. Shallow wells consequently exist everywhere where beds of gravel or thin beds of sand overlie clays, that is to say, in places all over England, on high grounds and on low grounds, as well as in valleys where the line of water level is, from other causes, within easy reach of the surface. It is this facility of obtaining water on the one hand, and of drainage on the other, in shallow water-bearing strata, that has led to the pollution of the water I have before pointed out.

While every house or every village has found in the permeable stratum its ready water supply, each one has also found its convenient pit for the drainage of all house sewage. Graveyards, manufactories, and other sources of organic impurities in the same way drain into the common spring underground, and contribute to the general mischief. It is only surprising that the consequences are not more serious. Few houses, whatever their character and importance, are, under these geological conditions of water-supply, free from this lurking and insidious evil, which is, probably, more than any other the frequent cause of illness and disease (though often in a form not to attract attention for years), in towns and villages which would and should otherwise, from their position and build, be chosen for healthiness and cleanliness. For this reason good surface springs, or some good selected source for common supply, would prove of much importance to our smaller towns and villages. For detached houses it is difficult to see what remedial measures can be applied, except better knowledge on the part of builders or adherence to obligatory rules.

Springs.—If left to itself, all the surplus rain supply stored in the hills escapes as springs; and these, although small compared with rivers and lakes, form very valuable supplies where the strata are of sufficient dimensions to afford exten-

sive filtration, and maintain a permanent and large delivery. They have the advantage over wells in that they are natural water channels, enlarged by time, and from which all the more readily soluble matter has been removed by long wear. When, therefore, such sources of supply are available, they are amongst the best and most desirable that can be adopted, although their volume is generally such as to limit their use to villages, or to towns of moderate size. As an illustration of this source of supply, there are the fine springs of the Oolite hills in the upper part of the Thames basin, which I have pointed out for the water supply of Oxford,* or which might, together with the great Chalk springs of the lower part of the same valley, be made available, as a potable water, for the use of London.

The value of a pure water supply is so inestimable that, except on the score of cost and inconvenience, I see no reason why a separate supply of potable water from this or other sources should not be introduced into our large towns, as has been already proposed for London, where the water requirements for ordinary purposes is so vast, and the difficulty of filtration so great and becoming year by year more unmanageable. Springs of moderate volume exist in most parts of the country. The chief of these in the Oolite and Chalk districts of the Thames valley, will be seen on the hydrogeological map I prepared some years since, with contour lines furnished by the late Sir Henry James, to accompany the report of the Water Commission, but which, though printed, has never been published. An inspection of this map (a copy of which accompanies this communication) will show how numerous are these springs in the Thames basin, while the sections across the same basin show how large the volume of water stored in the hills is, and what portion of it goes to form the perennial springs, or may be drawn upon by deep wells. It will be noticed that one set of springs is dependent upon a lesser head of water than others, and that from the geological structure of the country, it is not difficult to determine to which order any spring may belong. The villages and towns which might be supplied by these means are many, and no better supply could be desired, even if it were limited only to the supply of drinking water.

Rivers.—With respect to this more ordinary mode of public supply, it is a sound principle laid down by the Water Commission of 1869, that each river catchment-basin should supply, as far possible, its own population. There are cases, however, where the population of one basin being much under its amount of water supply, no inconvenience could arise in diverting a portion of the surplus supply from any source to places in adjoining basins, where the population is in excess. So long, however, as this does not happen, and the river waters are maintained in a state of sufficient purity, so long should the towns in each catchment basin look to the rivers and springs in that basin for their sources of supply. Under the improved system now inaugurated, it is to be hoped that many, if not most, of our rivers may be rendered (if they are not so already) available for the water supply of the towns on their banks. This subject is so fully treated in the report of that Commission, on which I had the honour to serve, that I need say no more about it. Nor do I think it necessary to go into the question of hard or soft water which the Commission also fully discussed. The conclusion I drew was, that it was really a matter of very minor importance, compared to the great importance of freedom from organic matter. Both waters, avoiding extremes, are perfectly wholesome, and as a question of preference, it seems to be very much one of use and custom. Pure lake waters do not seem, as a question of health, to be better than pure chalk waters, or pure river waters.

Rivers subject to floods should store a portion of their flood waters, and so better regulate their delivery during dry seasons. Their volume, however, depends not only on the rainfall, but on the geological character of their catchment basins, a subject which will also be found fully investigated with respect to the Thames and the Severn in the report of the same Commission. As an admirable instance of the study of the *régime* of rivers and of water supply to towns, I would refer to the late M. Belgrand's hydrological and geological map of the catchment-basin of the Seine, with its accompanying tables and report.

In the foregoing remarks, I have merely attempted to give general outlines of where our towns and villages may look for their water supplies, and to point out, also generally, the risks run of organic contamination in the different sources of supply. A careful selection of the one, and the application of proper restrictions to the other, cannot but be a matter of the highest importance, requiring the most careful consideration. It is not possible, in a communication of this kind, to go into the details of particular districts. Each one must be the subject of special inquiry, with respect to various conditions, of which that of geological structure is one of the most essential, whether as regards the sources that should be chosen as well as those which should be avoided. The existing evils arising from contamination are so serious, that the probability of this has, in each case, to be considered, and a remedy, where needed, applied. This is a matter of considerable difficulty, as without some knowledge of geology and chemistry, it is not easy for those whom it is intended to relieve to see or understand the necessity for change, especially where the polluted waters are, as is so often the case, cool, sparkling, and pleasant, and where, further, the change involves cost and trouble. Authority is needed in such instances to effect changes which are indispensable, or to carry out a combined plan of public supply from new sources for the general benefit of the community. Much information on the subject is already furnished in the map of the geographical survey, in the Reports of Royal and Parliamentary Committees, in special works and papers, in scientific periodicals, and in the Reports to the British Association.

* "On the Water Supply to Houses and Towns, with Special Reference to the Town of Oxford." Parker and Co.

WALTER T. SHUTE, Assoc. Inst. C.E.

It has often been proposed to construct large reservoirs at suitable localities along the valley of the Upper Thames.

This would not only provide an ample supply

of sufficiently pure cool and soft water, at all seasons of the year, for the supply of the metropolis and of other towns and lands on or near the river below such reservoirs, but would also lessen, if not prevent, injuries from floods along the course of the Thames, from Oxford to Kingston; which floods of late years periodically cause great damage, owing to modern improved subsoil drainage taking the rainfall quicker into the river.

Sufficient storage should be provided also for the irrigation of all farm lands requiring it in the neighbourhood of such reservoirs (as far as possible by gravitation). And these reservoirs, with the flow of the river as well, will provide a cheap source of power hitherto too much neglected in most parts of the country, for raising water, either for town or farm use, or for driving mills and machinery, and doing other useful work where required.

The chief difficulty in providing such reservoirs is the cost of the land required to make them of sufficient size to store the winter floods for summer use, but there are many suitable localities where, by dams across the lower mouth of the narrower valleys, large and deep reservoirs might be constructed on soils sufficiently retentive to prevent loss by leakage. And even if two or three such reservoirs would not hold all the flood water from extraordinary rain or snow storms, yet they would much mitigate the ill effects of floods, for by retaining the greater part of the upland floods, the extent of floods below is reduced. Proper provision for overflows will of course be provided.

During floods the water from these reservoirs would probably require filtration before being fit for drinking or for house use, but at other times such large deep lakes, too large for their water to become stagnant, would (after all sewage and manufacturing refuse is excluded from the rivers above them) provide an unfailing supply of good water to London at as high pressure as required, and by gravitation only without any pumping; the advantage and economy of which, for house supply, for extinction of fires, for cleansing of streets by jets, and as a source of power for driving machinery without using up or wasting water, are now too well recognised to need enlarging on here.

These large lake reservoirs would also provide a pleasant and easily accessible health resort for Londoners at holiday times, and, with good fishing and boating attractions, they would add much to the charms of the river.

By their means also the navigation of the upper Thames might be further improved, as water for a constant depth of river could be regularly maintained at all seasons, even the driest.

The cheapness of coal has hitherto caused some neglect of the still cheaper power available from a flow or pressure of water, which can now be made to drive any machinery without waste, the water not being fouled at all by flowing through, but being equally available for use again after doing its work. Such hydraulic engines (with or without accumulators as required) will probably be largely used in future, having such great advantages in cheapness, safety, convenience and cleanliness, over steam engines, and also requiring little or no attention whil at work. Provision can be made against the effects of frost, which, however, is seldom so severe in this country as to interfere with a regular flow of water.

Another cheap, simple, and durable hydraulic machine is the hydraulic ram, which, though of old date, and most constant and effective in action, is still but little used. By its means, wherever there is any slight flow or fall of water, a part of such stream can be raised to any reasonable height and distance; and this machine can be so constructed and adapted, that if worked by an impure stream, it may raise from another purer source.

The stream and the falls at the weirs of the upper Thames, as well as the tidal movement lower down the river, might also all be made to do far more useful work than at present. The power now wasted at the weirs especially could haul up river all the barge traffic against stream, by means either of an endless chain laid along the bed or side of the river, and put in motion by water-wheels or turbines at the weirs, or by many other methods of hydraulic working, which will easily suggest themselves.

Any extensive plan of water supply for London must be of great first cost. The plans lately proposed of sinking artesian wells into or through the chalk round London, and then pumping up this water into reservoirs, to be constructed at Hampstead or other high localities, are not free from objection for this and for other reasons. Such water would be harder, without being purer or more abundant, than that derived from reservoirs as proposed on the upper Thames, which, by their supply of water to towns under pressure, and for checking conflagrations, and as a source of motive power, and by their irrigation of lands and prevention of floods, would probably in time prove remunerative as well as sanitarily advantageous. The pipes of the present London water companies could be used in connection with these reservoirs, and their head of water would probably save much of the present pumping expenses; whereas the artesian well system would necessitate a double system of house-water pipes.

The importance of the question of the future water supply of London consists in its being mainly dependent on the Thames, since all other present sources supply but little over one quarter of the total amount required; and, except by more artesian wells, it does not seem probable that these other sources can be easily increased. Besides this, the Thames is itself fed by a rainfall which we cannot alter nor increase (as its watershed area is naturally fixed), and at present it is deprived of one-fifth of its flow in dry weather by the water companies drawing from it, whose demands will increase annually with the population. For these reasons, the storage of the flood waters, now so injuriously wasted, seems the best and most natural method of increasing the water supply for the metropolis, and for the use of other towns and lands, along the course of the river, by means of reservoirs, where possible.

The population of the metropolitan area, which is supplied chiefly by water companies (since there are now but few private wells in London, nor much collection of rainfall for house use there), is now about four million persons, who now use on an average 120 million gallons of water daily, and over two-thirds of this is drawn from the Thames,

which is still slightly polluted with sewage, and often also of too high temperature in summer time.

The lakes in Wales and in the north of England will probably find other claimants for their water, and, like any large distant gathering grounds, would prove expensive sources of supply for London. And to the artesian well system there is the objection of a complicated and expensive double system of house-pipes, besides the risk of its drying up other streams, wells, and springs in the neighbourhood.

Besides laying several pipes from the proposed new reservoirs up the Thames to join the works of the existing water companies near London, it might also prove advisable to cut a new straight artificial channel or canal (in addition to the present winding course of the river) from these reservoirs to the tidal limit, now at Teddington, and of sufficient size to help carry off floods, and to facilitate navigation. This would have locks and overflow weirs where required, and would save one-half of the present distance of water between Reading (or above) and Teddington, and would also benefit the towns and land on its course by supplying them with water and means of communication with the canals of the south, west, and centre of England.

Should large reservoirs be found too difficult or expensive in construction, then a number of smaller reservoir ponds might be substituted by forming dams below each of the present weirs, either in the present bed of the river or at its sides. Each of these would hold a small portion of flood water before overflowing into the river below, by having their side banks raised between the weir and the dam, and so would collectively be of some assistance in flood time. These must be gradually drawn off, so as not to flood the land above or below them. Fifteen or twenty of such storage ponds would hold a considerable supply, and as such reservoirs would be useful in times of drought, as well as in floods, this system seems worth consideration, as well as the construction of larger reservoirs, say, near Henley, and also above Reading.

The tidal portion of the Lower Thames could not be injured, but probably would be improved, by any such storage of floods above; and, fortunately, there are not many mills or manufactories on the Thames which would be so interfered with as to render compensation necessary.

G. J. SYMONS, F.R.S., Hon. Sec. Met. Soc., &c.

Englishmen have, as a rule, so strong an objection to centralisation, and such an attachment to old institutions, that it is a rather thankless task to point out evils and suggest remedies. Truly, our institutions and customs must be superhumanly good if those of each century are the best for all time, in spite of an increase of population which is so rapid as to stagger those who investigate it. I do not intend to consider fully the probable population of this country fifty or a hundred years hence; but if the existing rate goes on, it will in England and Wales alone be upwards of 100 millions; or, in other words, there will be four people to provide for, for every one there is at present. These, and other still more startling facts, are fully worked out in a remarkable address, delivered by Mr. T. Hawksley, C.E., as president of the Health Department of the Social Science Congress, at Liverpool, in 1876, which I strongly recommend to the attention of all who desire to survey matters on a greater scale than that of the few years in which we happen to live.

The first point which I desire to impress upon the meeting is, that we ought to look ahead, and make arrangements sufficiently elastic to provide for at least four times the present population.

The next question is, whether there will be water enough for such a population; but before answering it, I shall probably be excused for giving some information respecting the organisation for observing the amount of rainfall, *i.e.*, the gross national water supply, and the results obtained. English Governments scarcely ever originate anything; this could be proved by scores of instances; but to take only one. Can anything be of much more national importance than precise knowledge of the mineral resources of the country? But who made the first geological map? Why, William Smith, at his own cost, and without a sixpence of national help; and when it was done, did the Government take it up, and carry it on? No, not for half a century; our School of Mines is but, as it were, of yesterday, and our Geological Survey of the day before. So has it been with the determination of the rainfall of the British Isles; it has been left entirely without Government support. Fortunately, I have been able to enlist the assistance of a staff of observers of which any Government might be proud, nearly two thousand in number, spread over the whole extent of the British Isles, working in unison, and even contributing towards the cost of reducing their observations, and printing them. If governmental action should be taken upon this subject, past circumstances indicate the two forms which it would probably assume. If taken promptly, an entirely new staff would be created, at a heavy cost, to supersede the present voluntary one; otherwise matters will drift on until some time in the twentieth century, when the Minister of the day will inform the House of Commons that the question of water supply, both for the supply of towns and for motive power, is of such national importance, that the Government has resolved upon forming a hydraulic department, for the purpose of considering all questions of water supply, from its original deposit as rain until it passes back again into the ocean.

But to return to facts. The map on the wall was prepared some years ago, upon the best data then readily obtainable, in order to show approximately the average distribution of rain over the British Isles. The broad general features are all that we need, on the present occasion, and they may be stated in a very few lines.

1. If the British Isles were of uniform elevation, *i.e.*, without hills or valleys, the rainfall would be about 40 inches on the west coasts, and would decrease gradually to about 25 inches on the east.

2. The presence of hills always increases the deposit of rain; as a *very* rough approximation, it may be taken as an increase of 3 per cent. for each 100 feet of altitude; but this must be distinctly understood to be liable to great exceptions.

3. The actual deposit of rain over the British

Isles is the product of the combination of the two general facts just mentioned; and we therefore find enormous rainfalls among the mountains in Wales, Cumberland, and Scotland, and we doubtless should do so likewise in the south-west of Ireland if we had records from the mountains of Kerry.

4. Hence we arrive at the final fact, that although no part of the British Isles has, on the average, less than 20 inches of rain per annum, yet the bulk of the supply falls upon elevated mountain tracts, where it ranges from 50 to more than 100 inches per annum.

5. It may be well to state, that having collected and discussed an enormous mass of returns of rainfall, some of them two centuries old, I am in a position to affirm that the above conditions may be accepted as true for all time to come.

It is a curious and most favourable circumstance, that these high lands are almost always of a very hard and impervious material. If they were soft and porous, the excessive rainfall would almost wash them away, and the water would flow from them so charged with mineral matter as to be unsuited for use, to fill up the beds of the streams, and be always forming new ones. The beneficence of the present arrangement is equally proved by reversing the assumption and considering the hopelessly water-logged condition which would exist in the eastern counties of England, if the rainfall of the lake district were precipitated upon them.

We arrive then at the fact that the bulk of the rain falls on high and impermeable lands, and as the population are almost wholly resident in the valleys and plains, it follows that this mountain water is unpolluted, and the only problems to be solved are, how to store it to the best advantage, and how to carry it to the lowlands where it is required. Surely it is not very creditable to our skill or energy that we have still to discuss these points. Why are we staggered at works which (considering the powers at our command, *e.g.*, steam, electricity, and gunpowder) are quite trifling compared with those of the Romans, which we admire but do not imitate?

It will be very instructive to consider why Englishmen have never taken a broad and comprehensive view of this subject, and although it will compel me to appear discursive, I hope that you will not deem the time devoted to it to have been mis-spent.

Education seems a subject very foreign to a discussion upon water supply, but my own belief is, that if English education had been as practical and thorough as it could be, and should be, the present meeting would have been held half a century since. Provided that the general public have sufficient water for their personal use, and that it looks tolerably clear in their water bottles, they think it is all right; they rarely know where it comes from, or pay the slightest attention to its preservation from waste, or from impurity, by cleaning the cisterns, while consideration for the supply, even for children now living, is about as popular as the study of tidal constants. And our law makers, both elected and hereditary, though the very cream of the country, have they had that technical training, have they that breadth of view which is necessary? I wish they knew a little more of physical geography and a little less of Homer.

Vested interests have been gradually raised in England almost to the rank of a deity, the result being that the cost of public improvements is so ridiculously great, that scarcely one is carried out for a dozen that are needed. It used to be supposed that the welfare of the public was of the first importance, and that private must give way before public interests, but we have reversed that, and doubled the cost of desirable works, by the enormous compensation which it is the fashion to give, even sometimes for purely imaginary injury. The perpetuity of our Acts of Parliament has already been referred to, but not at the length which the importance of the subject deserves. Can any but a superhuman intellect determine what will be best a century hence? Yet our laws are made for perpetuity, and directly they are found to require modification, Acts of the past or present century are brought forward, and the rights then created have to be re-purchased at a frightful cost. Would it not be well to study the practice of our French neighbours in this respect?

The enormous cost of contests before Parliamentary Committees is another serious evil, for it is such that only wealthy bodies can face it, and no matter how impartial the committee may be, the richer party generally exhausts, and rides over, the poorer one.

I venture to reproduce here a sentence from a paper which I read last year before the Institute of Surveyors, as it appears to me to sum up concisely my objections to the present state of matters, and also to point to the remedy:—

"Another respect in which the existing mode of private Bill legislation is creating rights of very doubtful public expediency, is the granting of absolute water rights over large tracts of land to the first body, whether company or corporation, which asks for them, and comes to terms with the landowners, and with the millowners on the stream. Surely the wise and proper course would be to stop the present scramble, in which the wealthy and the venturesome have it all their own way; to have a careful survey made of the still unseized lands available for gravitation waterworks, and then (subject to all proper payments by the parties taking them) let them be appropriated to the various communities in conformity with their proximity, and with their requirements."

I wish I had the time, and the money, wherewith to prepare a set of maps of England, showing the different ways in which it is divided, for their great number would impress you far more than anything that I can say. We should have counties, electoral districts, dioceses, registration districts, poor-law unions, county court districts, rural sanitary districts, and probably many others, all different, and not one with any physical features to define it, or any *raison d'être* except its actual existence. I should be very sorry to propose to add to the number, but I cannot help thinking that the right division for all hydraulic questions is the river basin, and that as regards fishing, water power, water supply, drainage and sewerage, it would be a grand thing to have one supreme authority for each river basin. But I suppose it is impossible, for such a body would find itself bound hand and foot by vested interests, some

recently created, others, venerable perhaps from their antiquity, but as likely as not resting on some love freak of one of our early kings. Probably the time will come when the welfare of the whole people will take its proper priority, but that time is not yet. Respecting water supply for poor rural districts, I made several suggestions in a paper read before the Social Science Congress at Liverpool, in 1876; I adhere to these, but will not occupy time by repeating them.

In conclusion I will try to epitomise my views.

1. The quantity of rain falling cannot be increased.

2. The population is doubling about every 25 years.

3. The larger the population the more water will be fouled.

4. There will, therefore, be less clean water in future years, and yet there will be two, three, or four times the population even within a century.

5. Entirely new arrangements will, therefore, be necessary.

6. It would be much better if the entire administration of streams was under a single direction, which should see to all questions of drainage, sewerage, canalisation, motive power, and water supply.

7. Such new works as are required promptly, should only be authorised subject to their reverting to Government in 50 or 100 years.

8. All other hydraulic works should be undertaken, or at all events supervised, by a Government department, so as to ensure the greatest possible public benefit, and not merely that of an individual town.

9. These objects will be best obtained, and a very large national saving will be effected, by gradually organising an hydraulic department, resembling, as much as possible, that of the *Ponts et Chaussées*, with a training school attached fitted with laboratories, &c., like that at Paris. There is no reason why such a department should not confer upon England advantages equal to those which the similar office has conferred upon France. Are we too proud to learn from our neighbours?

GEORGE FREDERIC WILLS.

His Royal Highness the Prince of Wales having signified his desire to obtain information on the very important subject of the supply of water in the country districts, I venture to offer some remarks on the subject, having for many years studied it, and endeavoured to improve in my locality the supply to the towns and villages around me, in which, as a surgeon, I am in the constant habit of observing the lamentable deficiency.

The chief obstacle in the way of obtaining proper water supply is, I believe, the constitution of the local authority. This, in rural districts, is largely, sometimes almost entirely, composed of farmers, who are the chief ratepayers, and whose object naturally is to keep the expenditure at a minimum, as their own pockets suffer most from local rates; and although in sanitary measures land is taxed less heavily than houses, yet it is certain that farmers' houses, and their labourers' cottages, scattered, as they are, in the country, derive (directly) little, if any, benefit from money expended in sewerage or in water supply. They are, therefore, extremely averse to such expenditure, especially as most of them hold their lands on lease, or even yearly agreements, and are therefore unlikely to reap advantage from the later and indirect benefits which such sewerage or water supply will probably confer on the district.

I do not see the possibility of much being done, unless by a superior authority requiring it in those cases where the necessity has been shown.

Allow me to instance one town. A few years ago it was urged by the medical officer of health that a water supply was required. Clear proofs were given by him and others that the wells were polluted. A resolution was passed by the sanitary authority that the water supply was inefficient: the Local Government Board urged the necessity of bringing water to the town. The Local Government Board's inspector said it was essential, but from that day nothing has been done to bring pure water, and the matter remains as it stood at first. A general system of sewerage has been carried out, but there is a very inefficient supply of water. I see no remedy under the present law for this deficiency. The sanitary authority is now composed mainly of agriculturists, who would not vote for a heavy expenditure, because it would affect the farmers chiefly, who would derive no direct benefit from it; and I cannot but agree that it presses hard—unduly hard—on them in such cases; and I suppose it is from this cause that the Local Government Board are silent, and allow an acknowledged deficiency of pure water to continue to be an infliction and source of disease to the inhabitants. The remedy for this seems to me to be the compulsory formation of a "district" or "local" Board, which shall raise requisite funds from the locality immediately benefited, and not including farms, lands, or dwellings out of the reach of such water supply.

Then as to villages and small hamlets. In many districts the sanitary acts are a dead letter. The sewage still follows its old course, permeating the soil, contaminating wells, and not being carried away by any drain or sewer. Out of sixty villages within a few miles of this town I do not know one which properly carries away its sewage. What wonder, then, if fever, diarrhœa, consumption, and other preventible diseases still continue to demand their yearly victims. The sanitary authorities do not interfere from the reasons I have given, the Local Government Board make no inquiry and receive no information, and the public rest contented so long as none of their own families fall victims. If the Local Government Board would only make it compulsory on sanitary authorities to print and circulate the reports of their medical officers, a wonderful change would be effected by the information such reports would give.

The Belgian Chamber has recently rejected a proposal for excluding females from work in Belgian coal mines, and has accepted a ministerial amendment fixing the minimum age of boys working in the mines at twelve, and that of girls at thirteen years. The work performed by women in the Belgian coal mines is usually loading trams, and putting or hauling them down into the main roads, and attending doors.

MISCELLANEOUS.

ELEMENTARY SCIENCE IN SCHOOLS.

The discussion which took place in the House of Commons on this subject, on the 4th July, has so important a bearing on the progress of Public Elementary Education, that a corrected report is given of Sir John Lubbock's speech, and the points of practical importance raised by other speakers are briefly noticed for future reference. What is called Elementary Science is the science of common things, is at the basis of all technical instruction, and is especially connected with the subjects which the Education Department has classed under Domestic Economy, the proper understanding of which the Society is doing so much to promote:—

On the motion to go into Committee of Supply on the Education Estimates,

Sir J. Lubbock rose to move:—"That it would be desirable to modify the Code of Education by adding Elementary Natural Science to the subjects mentioned in Article 19, C. 1." By natural science he did not mean anything difficult or abstruse, but simple explanations of the ordinary phenomena of nature and of the world in which we live. He would, in fact, have been glad to avoid the word "science," but we had no expression equivalent to the German *naturkunde*. According to the provisions of the clause just referred to, the sum of 4s. per scholar was granted if the classes from which the children were examined in Standards 2-6 passed a creditable examination in any of the following subjects—viz., grammar, history, elementary geography, and plain needlework. It was evident, in these circumstances, that no other subjects could or would be taught generally in elementary schools. In the whole of England and Wales, according to last year's report, out of 3,000,000 children in our elementary schools, only 200 passed in more than two subjects, so that if history, geography, and grammar, or any two of them were made compulsory, other subjects were practically excluded. To prescribe any exact course of education to be followed in all elementary schools, independent of circumstances, was a mistake. Having too long left education entirely unregulated, we had now gone to the other extreme and taken it almost entirely out of the hands of local bodies, the control being practically centred in Whitehall. Under this and other clauses the Code of education laid down such minute rules as to what was to be taught that school committees and even schoolmasters had little voice in the matter. The best men would gradually cease to serve on School Boards if they were deprived of any voice as to the education to be given. It must be a mistake to prescribe an exact canon of education until we were quite sure what system was the best; but on this point the highest authorities were much divided. The Education Department practically excluded science. But the committee of this House which sat in 1868, under the able presidency of the hon. member for Banbury, strongly recommended that "elementary instruction in the phenomena of nature should be given in elementary schools." Again, the Royal Commission presided over by the Duke of Devonshire reported that in their opinion instruction in the rudiments of physical science should form a recognised part of the school course. He could quote numerous high authorities in support of the same opinion. Dean Dawes, for instance, and Mr. Henslow, who founded two of the most excellent of village schools, attributed much of their success to the introduction of elementary science. He did not ask for anything difficult or abstruse, but referred to such points as the causes of day and night, of summer and winter, of the phases of the moon, the difference between the stars and planets, the cause of eclipses, the tides, the composition and properties of air and water, the nature and characteristics of soils—in chalk districts dwelling especially on chalk, in coal countries on coal; the simple forces, the lever, pulley, wheel, screw, and wedge; the ordinary rules which regulate health, to which he should also like to add some knowledge of the commoner objects by which the children were surrounded. These matters should be treated in a very simple and easy manner, and would be extremely interesting to the children. Our education was at present entirely derived from books, and the contact with things, with actual objects, would prove extremely beneficial. He could prove to them by the most abundant testimony from many of our best schoolmasters and of our most able school inspectors, by our most eminent men of science, and by the actual cases of schools in which the experiment had been tried, that science properly taught was most instructive and delightful to children. He was not proposing to make science obligatory, he only wished that an option should be given to school authorities that a knowledge of the elementary facts of nature should in our elementary schools be put on the same footing as history, geography, and grammar. Last year new conditions and limitations were, in the Scotch Code, attached to the teaching of science subjects, not because they were too difficult, but on the express ground that they were learnt by the children too easily and quickly. This change of front seemed to be founded on the report of the Board of Education for Scotland. Hitherto science had been discouraged on the ground that it was too difficult. In Scotland, nevertheless, it had proved so interesting to the children that it began to force its way into the schools and the Board at once took alarm. If children learnt the amount prescribed so easily, surely the proper course was to demand a little more. He thought that the differences of opinion on the subject of science teaching in elementary schools were partly apparent, and arose from the word science being used in different senses. Mr. M. Arnold, whom he had hitherto supposed to be of a different opinion, had, in his last report, expressed himself as follows:—"I should like to see what the Germans call *naturkunde*, knowledge of the facts and laws of nature, added as a class subject to grammar, geography, and English history. I would require the teaching of all four as class subjects, in every elementary school, to all scholars above the third standard, girls as well as boys. For the second and third standards I would have grammar as at present, and, in addition to grammar, the element of *naturkunde*." Perhaps Mr. Arnold's proposal might be at present impossible, because our teachers had not yet received the necessary training; but the course now proposed would prepare the way for its adoption eventually. Some high authorities were of opinion that history and grammar, as taught in our elementary schools, were by no means suited to occupy the exclusive position now assigned to them. Of history, what was taught in elementary schools was little more than lists of dates, and kings, and wars, and it might be a serious misfortune that we accustomed our children to regard war as almost a normal state. As to grammar, the right hon. member for Birmingham (Mr. Bright), in a speech made in connection with an educational institution, said:—"If there is any lad here who is engaged in learning grammar, I will undertake to say that he will say it is the very driest and most unpleasant study that any person ever put himself to. When I was at school, which is a long time ago, we learnt a grammar written by Lindley Murray. Lindley Murray's grammar had a great reputation then, and, for anything I know, has yet; but if it has, I pity the lads that have to learn it. There are no end of rules, and no end of examples; rules within rules, and exceptions of all kinds; and I have now a feeling of utter confusion in my mind in endeavouring to understand all the rules of Lindley Murray's grammar. My opinion is that it is very difficult for any person who

reads well written books, and understands them, not to acquire a very competent knowledge of grammar." Goëthe, also, he might say in passing, expressed a very similar opinion about grammar. Surely, such an opinion, from such an authority, was entitled to very great weight. He did not, however, ask that grammar should be excluded. He merely wished that it should not be put in such a position as to exclude other subjects. He only asked that school authorities should be allowed the option. Moreover, even suppose that the amendment he had ventured to move was adopted, and that a school elected to give a certain amount of instruction in natural knowledge, this need not by any means exclude any of the existing subjects, because some might be taken up for one part of the school course, some for another. But, even supposing that all educational authorities were agreed upon an ideal system, still to impose one identical course on all schools alike would even then be undesirable. As regards the upper standards, at any rate, some consideration should be given to locality. Schools in country villages and in great towns differ very much. Again, the staple industries of the neighbourhood should be taken into account. Something, again, must depend on the schoolmaster. Surely, then, to lay down such minute rules in the Code was a great mistake. It was, moreover, remarkable that the Government to a certain extent admitted this, because they did not impose on Scotland or on Ireland the same system as on England. But different parts of England differed far from one another, than the North of England did from the South of Scotland. Surely again, in some of our large towns, it might be well to give the upper classes, at any rate in some of the schools, some elementary instruction which had reference to the staple industry of the neighbourhood, in coal districts for instance about coal. He might be told it was not desirable to modify the Code again; but even if we admitted that it would not be desirable to adopt any resolution which would impose additional obligations or requirements on schools, the objection did not apply to such an alteration as that now proposed. He asked nothing new of the schools, of the Education Department, or, indeed, of any one. If school committees did not notice the change, or did not care to avail themselves of it, no harm would be done. They would only give them an option, which they might use or not, as they thought best. Their eloquent countryman, Mr. Ruskin, had truly said that "The whole force of education, until very lately, has been directed in every possible way to the destruction of the love of nature. The only knowledge which has been deemed essential among us is that of words, and next after it of the abstract sciences, while every liking shown by children for simple natural objects has been either violently checked or else scrupulously limited to hours of play, so that it has really been impossible for any child earnestly to study the works of God, but against its conscience; and the love of nature has become inherently the characteristic of truants and idlers." Hitherto he had urged this resolution on educational grounds, but he should like to say a few words on another aspect of the question. There was always in every country a tendency to and a danger of centralisation. The advantages of each step in this direction were obvious, the dangers perhaps all the more perilous, because they were below the surface. Our municipal institutions were a great bulwark of our Parliamentary liberties; local self-government was an almost necessary training for Imperial self-government. From this point of view, also, it seemed very important that the power of local authorities should not be unnecessarily curtailed. He had attempted to show that the Code in its present form laid down unnecessarily minute rules for the conduct of schools, that one branch of human knowledge was practically excluded, that the highest educational authorities were still divided in opinion as to the best course to be pursued, and that the amendment now proposed was permissive in its character, that it simply gave to local authorities a power which until recently they possessed, and which there was no allegation that they in any way abused. He was very anxious that their lessons should be made as interesting as possible to children; for, they may learn them ever so thoroughly—may learn their grammar by heart, and all the dates and crimes in history—but, if they hate their lessons all the time, we shall have done them little good. What Ruskin said of ornament, applied equally, perhaps more, to education. "The right question to ask is simply this—Was it done with enjoyment, was the workman happy while he was about it?" He would say the same of children. He believed that the knowledge which their children would acquire by the introduction of elementary science would not only be useful in itself, but that it would render their lessons more interesting, and, therefore, make them more instructive. In that belief, he commended his amendment to the favourable consideration of the House.

Sir U. Kay-Shuttleworth had great pleasure in supporting the motion of his hon. friend. Experience showed him that there would be no difficulty in carrying its object into effect. In the humblest town in Germany children were supplied with reading books containing all that it was deemed necessary to teach with regard to natural history and other cognate subjects, and that teaching was combined with the ordinary elementary instruction which they received. He should, however, not like to see instruction in these extra subjects pushed too far, and his hon. friend had, he thought, put the matter on its right footing.

Mr. D. Davies would not oppose the motion, of which, indeed, he rather approved.

Mr. B. Samuelson remarked that though the inspectors of schools did their work thoroughly and well, their University training usually prevented them from having much knowledge of natural science, and he wished for the appointment of competent examiners as well as of competent teachers. The great number of alterations made in the Code had been mentioned in the debate, and had rendered it almost impossible for the noble lord to object to one more, which, if it resulted even in the reconstruction of the Code, would do no great harm.

Mr. Ramsay thought no amount of education unfitted a man for manual labour, and in agriculture especially some little knowledge of science was very useful.

Mr. W. E. Forster said that the hon. baronet the member for Maidstone had so well stated the case in favour of his motion that there was very little to be added to his arguments. Although hitherto he had himself felt considerable doubt in respect to that motion, he confessed that he was now entirely inclined to support it. He did not think that, as it would be arranged to be taught, it would be one whit more difficult to learn elementary science than to learn history or geography, and it would not be found so difficult as grammar. There might be parts of the country where it was desirable, if they went beyond reading, writing, and ciphering, they should teach elementary science. Professor Huxley and other eminent scientific men had been considering how they could make the elementary facts of natural science easy to be acquired by children. His hon. friend, the member for Maidstone asked them to take advantage of that. In some cases a master might be better able to teach elementary science than any of the other subjects, and why should he not have the option of doing it? There was no reason why that should not be put along with the other extra subjects. That would involve some alteration in the standards, and the noble lord could consult with those who were most competent to advise him as to how the thing could be best carried out. If the noble lord did not at once accept the motion, he hoped that he would not put it altogether aside, but would consider whether it might not be

adopted at the next revision of the Code. In making that request he was not suggesting that they should pester all the children's brains with more subjects. But he thought that, both as regarded the real knowledge it would give them, and as regarded their preparation for the callings in which many of them would have to earn their bread, it would be desirable to place the teaching of elementary science alongside of grammar, geography, and history.

Lord G. Hamilton said the hon. baronet had certainly succeeded in making a considerable number of converts to his proposals, and the right hon. gentleman who had spoken last had admitted that he was prepared to a certain extent to support them. So long as the system of payment by results was continued, so long must there be a considerable amount of rigidity in order to insure uniformity in the subjects in which the children were examined. The hon. baronet proposed to add natural science to the subjects of instruction. That would make a great alteration. It would be necessary for that purpose to remodel the whole of the Code. What was natural science? It was very well for the hon. baronet to say that he did not mean anything difficult, although he cordially agreed with the greater part of the observations of the hon. baronet, he could not accept the amendment which he had moved. The wish of the hon. baronet was, he thought, to give as much elasticity as possible to the present system of instruction. He could assure the hon. baronet that any proposal which in his (Lord G. Hamilton's) humble judgment was practical would meet with no opposition from him; but when a proposal so wide as that which the hon. baronet had made to-day was brought forward, he had no alternative but to ask the House to reject it.

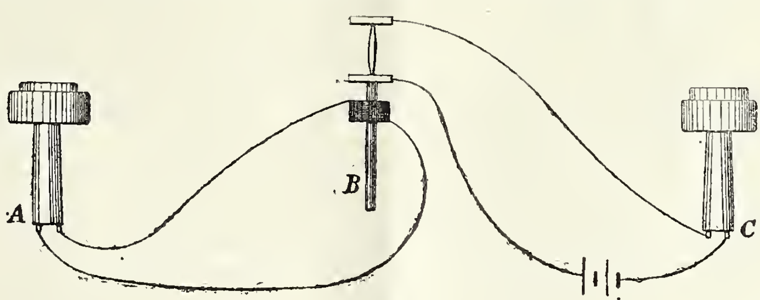
Dr. Lyon Playfair said the noble lord in saying that elementary science could not be added to the subjects taught because it covered so wide an area, might as well have said that history, for the same reason, could not be one of the subjects taught. The noble lord said it was impossible to introduce such subjects into the Code. [Lord G. Hamilton—"Without great alteration."] Without great alteration and great changes. He (Dr. Playfair) could speak with a little knowledge on this subject, because the Education Department had been good enough to adopt several definitions of various sciences which he had given. All that you required to do was to add to your standard a little elementary knowledge—he was not going to call it science, because it was the term elementary science which confused and frightened people. What was meant by elementary science? It was simply an intelligent acquaintance with the objects by which the poor children would be surrounded, perhaps, throughout their lives. His hon. friend had done good service in drawing attention to the subject, and it was one of all the more importance that foreign Governments were giving practical effect to that which his hon. friend suggested.

The Houso divided, when there appeared—For the resolution, 37; against it, 68; majority, 31.

THE MICROPHONE.

Mr. A. Haddon, Demonstrator in Physics, Royal Naval College, Greenwich, sends the following communication:—

While experimenting a short time back with Professor Hughes's beautiful microphone, I hit upon a method of rendering less sensitive the vertical form. As a rule, when speaking to the microphone there is a peculiar jar at the beginning of each word, due to the vibrations being too violent, and so probably breaking the circuit. Again if a musical box be placed on the the base board of the instrument, nothing but a continuous whir-r-r-r isheard; but by using a "bridle," as one might call it, in connection with the vertical carbon, one can control it and so cause an exact repetition of what takes place near the microphone at the other end.



The bridle consists of a piece of thin india-rubber, such as can be obtained from spring-side boots, one end is fixed to the vertical carbon by means of a hook, the other end being attached to a wire, so that by turning round the wire the tension can be increased to the desired amount.

By using this bridle in connection with the microphone one can transmit vibrations from a tuning-fork, musical box, &c. I have been able at times to hear a tune at from 20 to 30 feet from the telephone.

If a paper cone be placed in front of the microphone speech is reproduced at the other end quite as clearly as when Professor Bell's telephone is used, only much louder.

I find that when using a battery and the microphone it is possible to hear sounds, such as the ticking of a watch, even when the magnet is removed from the telephone, the coil of wire being sufficient to attract and release the vibrating plate upon variations in the strength of the current.

Using the same arrangement as above, only in this case removing the plate and replacing the magnet, one can hear distinctly sounds made near the microphone. This led me to try the microphone as a detector of vibrations in the magnet of the telephone; as far as I am aware, this, so far, has not been done before. I attached a microphone to the bare end of the magnet of a telephone, the coil being in the same circuit as another telephone, and the microphone was then connected to another telephone and battery. The arrangement was this—

Telephone A was spoken to, and telephone C used as receiver, so that any sound heard at C must have been communicated to the microphono by magnet B.

CORRESPONDENCE.

ALUM SUBSTITUTES FOR PAPER MAKERS.

Since the delivery of my lectures on paper making before the Society, in November, December, and January last, a new and remarkable facile and accurate method for the estimation of mineral acids in mixtures of salts of various kinds has been brought under the notice of chemists in a paper submitted to the Chemical Society, on the 16th May, by Mr. Peter Spence and Mr. Alexander Esilman (*Journal of Chemical Society*, July, 1878, p. 298). I feel called upon to direct the attention of your readers to it, and to point out how materially it modifies the analytical aspect of the aluminous compounds so extensively used in paper making. I have shown how very deleterious the presence of free acids in paper pulp is, and have warned the trade against the use of such compounds as contain any considerable proportion of them. The table embodied in my fifth lecture shows that almost all the cakes examined contained more or less free acid, the results in that table were obtained by the orthodox method of precipitating the sulphuric acid, alumina, &c., and, after giving the bases their due proportion of acid, setting down the remainder as "free." I find now that the method, though old, is not quite reliable, and is calculated to make almost all acid cakes better than they really are—showing more alumina and less free acid than they really contain. In precipitating alumina from solutions of commercial sulphate and alum cake, various foreign agents—such as arsenic, phosphoric, titanic, and silicic acids—go down with it, and add to the weight of the precipitate. Errors from this cause are, in large measure, independent of the precautions taken to ensure the entire insolubility of the alumina itself, and the elimination of any sulphuric acid that may have gone down with it. It will be observed that a unit of alumina takes up three, or nearly so (102·8 : 294), of H_2SO_4, so that the decrease of free acid is somewhat rapid compared to the increase in weight of the alumina precipitate. The new process, while not correcting the faults in the alumina determinations, puts the free acid beyond the influence of these faults; in fact, gives us a direct and independent determination. Spence and Esilman's process is "based upon the fact that peracetate of iron, even in dilute solution, has a distinct yellow colour, not perceptibly altered by acetic acid, or solutions of persulphates, but instantly bleached by free sulphuric, hydrochloric, or nitric acid." There are several modifications of the process, but the following is what I have found to work most satisfactorily.

A solution is prepared by dissolving 10 parts of iron alum and eight parts of crystallised acetate of soda in about 50 parts of water, which has previously been acidulated with 10 per cent. of 25 per cent. distilled acetic acid. 200 grains of the sample to be tested are to be triturated in a small mortar with, say, two ounces of the same acidulated water as was used in making up the test solution. The peracetate solution is now to be added from a burette until the mixture has acquired a decided yellow tint (no harm although the colour should be ever higher than this), showing that all the free acid has been neutralised. Dilute to 100 measures with the acetic acid water and filter off a portion into a test tube or tall glass. Into another tube of similar dimensions introduce as many measures of the peracetate solution as were used for neutralising and colouring the cake solution, dilute and add standard sulphuric acid until the bulk and colour correspond exactly with the bulk of the mixture and the colour of the filtered portion. The sulphuric acid used is the measure of the free acid in 200 grains of the sample.

Being very frequently called upon to analyse and report upon alum substitutes, I have subjected the Spence-Esilman process to a rigid scrutiny previous to adopting it in my own practice. I have not only examined many cakes with it, but have submitted it to the crucial test of the determining of free acid in mixtures specially prepared, and, therefore, of accurately known composition, with the result of thoroughly satisfying myself of its great superiority both in accuracy and rapidity over the old method. I may add that the effect of the standard upon the colour of the solution is so sharp and decided, that there need be no difficulty in obtaining results constant, within $\frac{1}{10}$ per cent. of the truth. To show the important difference in the results obtained by this method and by the old, I give the free acid results from the table given in my lectures, alongside those obtained by the new process, the same samples having been used in each case.

Maker.	Substance.	Free H_2SO_4 Old method.	Free H_2SO_4 Spence-Esilman Process.
H. D. Pochin and Co.	Sulphate of Alumina	4·72	7·10
McArthur and Link...	do.	3·70	6·54
Foreign	do.	none	·84
H. D. Pochin and Co.	Aluminous Cake	·30	2 71
Cochrane and Co.	do.	2·06	4·90
Winser and Co.........	do.	1·24	2·93
Peter Spence..........	Alumino-ferric Cake	none	·55

WILLIAM ARNOT.

18, Picardy-place, Edinburgh,
9th July, 1878.

GENERAL NOTES.

The Australian Overland Telegraph.—The total cost of the Australian overland telegraph was £370,000., or about £250,000 more than the first estimate. The amount was further increased by the substitution of iron poles for wooden ones where the attacks of white ants are dreaded. An interesting account has been given by Mr. Todd of the difficulties which the construction party had to surmount. In one year and eleven months 36,000 telegraph poles, weighing 5,000 tons, had to be cut, prepared, and carted, for an average distance of 400 miles. In addition to this 2,000 tons of material had to be carted, and several thousand cattle and sheep driven interior for distances ranging up to 1,300 miles. Moreover, tracks 50 ft. wide had to be cut and cleared through some 500 miles of forest and scrub. Building materials, batteries, and other stores had to be carried for the use of stations, and nine stations had to be erected and equipped. The line very nearly follows the tract of Stuart across the continent. The natives are found occasionally troublesome on some of the distant stations, and have at times speared some of the operators.—*Engineering.*

African Exploration.—The first report of the African Exploration Fund Committee of the Royal Geographical Society has just appeared. The committee suggest three schemes—the first for an expedition into the country between Mombas, Formosa Bay, and the Victoria Nyanza; the second —a proposal of Stanley's—for a careful examination of the valley of the Rufigi up to the highlands bounding the eastern side of Lake Tanganyika; and the third for examining the intermediate country between the new caravan route from a point a few miles south of Zanzibar to the northern end of Lake Nyassa. The third expedition has been resolved upon, and a party will be despatched in October. After reaching Lake Nyassa, it will endeavour to traverse the supposed caravan route connecting that lake with Tanganyika, 150 miles farther on. If the route from the coast is found practicable, small steamers will be placed on the two lakes, and a regular trade established. The committee report that a grant of £20,000 for the exploration of Western Africa beyond the confines of the Portuguese possessions has been made by the Portuguese Cortes; in France, a credit of 100,000 francs has been voted for a Central African expedition; and in Belgium, a sum of nearly equal amount has been collected; while the total amount hitherto received by the African Exploration Fund, including the £500 granted by the Council, has not reached £2,000.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,340. Vol. XXVI.

FRIDAY, JULY 26, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

PARIS INTERNATIONAL EXHIBITION, 1878.—ARTISAN REPORTERS.

The arrangements for the visits of selected artisan reporters to the Paris Exhibition are now complete. They are as follows:—

1. Artisans selected by the Joint Committee, or approved by them, will be sent to Paris at the expense of the fund now being raised by subscription, or at the expense of their employers, Local Committees, &c.

2. Each artisan is expected to devote from eight to fourteen days to the visit, including the time of his stay in Paris and his journey there and back. He must spend his time in the study of the Exhibition and industrial establishments in Paris; and must undertake to deliver to the Society of Arts on his return a written report on the special industry he represents.

3. Suitable lodgings, in the neighbourhood of the Exhibition, have been secured at a maximum charge of 20 fr. (16s. English) per week in advance. Good dinners, served as in England, can be obtained at 1 fr. 50c. (1s. 3d. English), or three meals a day will be supplied at 3 fr. 50c. (about 3s. English), at the Workman's-hall, also near to the Exhibition. Each artisan will have free admission at all times to the Workman's-hall, where are reading and writing-rooms, billiard and bagatelle-rooms, &c. Arrangements will be made to enable artisans, as far as possible, to visit industrial establishments and manufactories in Paris.

4. Each artisan sent at the expense of the fund will be paid £8. He will receive £5 on starting, out of which he must pay all charges connected with his trip. On delivering his report he will receive the balance of £3.

5. Free admission to the Exhibition will be granted through the Royal Commission to each artisan.

6. Each artisan will be furnished with a route card, by means of which he will be recognised at the railway stations, both in England and in France, and this will entitle him to attention from guards and other officials.

7. Arrangements have been made with the South-Eastern and London, Chatham, and Dover Railway Companies for the purchase of a return ticket to Paris and back, available for fourteen days, at the price of 20s. such ticket to be purchasable at the railway station, in exchange for a certificate provided by the Society of Arts.

8. In order to secure the above advantages, it will be necessary that notice be sent to the Secretary of the Society of Arts, John-street, Adelphi, W.C., at least ten days previous to the proposed departure, in order that he may communicate with the authorities in Paris to engage the necessary lodgings. It will greatly facilitate the arrangements that the men should go in parties of 10 or more.

9. The route will be from Charing-cross, Cannon-street, Ludgate-hill, or Victoria Terminus, by the trains of the night service. On arrival at Calais or Boulogne, the artisans will be forwarded by the Northern of France to the Northern Station, Paris, where parties of ten, or more, will be met and conducted to the lodgings provided as above. Artisans arriving singly or in small parties, should report themselves to the British Commission.

There are several ways in which advantage may be taken of the above arrangements.

1. Artisans may be sent direct, selected by the Joint Committee, and at the expense of the fund now being raised by subscription for the purpose.

2. Artisans may be sent direct, at the expense of their employers or Local Committee, and certified to the Joint Committee of Her Majesty's Commisioners and the Society of Arts. Such artisans will be supplied with the necessary cards and certificates, to enable them to take advantage of arrangements and facilities afforded by the Joint Committee.

3. Employers or Local Committees subscribing to the fund may select or send out, with the benefit of the advantages named above, artisans in number to the extent of one for each £10 subscribed, or subscribers to the fund may nominate, for consideration and selection by the Joint Committee, such artisans as they may think suitable to represent the special trade or trades of the district or party subscribing.

Subscriptions are sought from Local Committees individual firms or employers, to enable the Joint Committee to carry out the undertaking on a complete and successful scale.

CANTOR LECTURES.

THE APPLICATION OF PHOTOGRAPHY TO THE PRODUCTION OF PRINTING SURFACES AND PICTURES IN PIGMENT.

By Thomas Bolas, Esq., F.C.S.

Lecture II.—Delivered Feb. 25th, 1878.

Phototypic, or raised Printing Blocks, by Swelled Gelatine Process, Zinc Etching, and other Methods.

Here is a fatty ink transfer, similar to that which I put down on a lithographic stone during the first lecture. I now lay it on a smooth and clean zinc plate, and pass through the press. On removing the paper, by soaking, we find that the ink firmly adheres to the zinc, just as it previously did to the stone. A treatment with gum now protects the clear parts of the zinc plate against the adhesion of printing ink, and the application of the ink roller adds more ink to the fatty image already on the surface of the zinc plate. So far, our present process resembles the photo-lithographic process described last week; but, instead of printing from the zinc plate, I dust powdered resin over it, in order to give firmness to the fatty image, very slightly warm the plate, and make the resin and ink partially blend, and then put it into dilute nitric acid, containing one part of acid to about forty parts of water, and here it remains for about three minutes, during which time the acid dissolves away those parts of the metal which are not covered by the waterproof coating. Now, let us take the plate out and examine it. We find that the covered parts stand slightly in relief, but only very little, and if we were to continue the etching without further preparation, the acid would gradually undermine the lines, and the image would be lost. Now, the undermining action of the acid can easily be prevented by washing the plate, drying it, and then heating it sufficiently to just melt the resin. Under these circumstances, the melted resin blends with the printers' ink, and runs down over the sides of the little ridges left by the etching, and protects these sides from the further action of the acid. Having done this, it is well to gum the plate once more, ink again, dry and dust with resin before proceeding to another etching. This second etching may be done with stronger acid than the first, say one of nitric acid to 30 of water, and it may be continued longer, say, for six or seven minutes, and when this second etching is finished, the whole series of operations must be repeated until sufficient depth is obtained, care being taken that the melting of the resin is only carried far enough to allow it to flow just over the sides of the relief left by the previous etching. In ordinary cases ten etchings are enough to give the necessary depth, but in the case of important work it may be necessary to give twenty or thirty very slight etchings in order to obtain the same depth, without endangering very fine lines or details.

On the table are some zinc plates illustrating the various stages of the process, and there are also some admirable specimens of finished work by Messrs. Leitch and Co., and by Messrs. Dellagana and Co.

The process of zinc etching has been largely employed for the production of typographic blocks from fatty transfers, either drawn by hand or printed, and this phase of the process bids fair to compete successfully with the art of wood engraving.

There are other methods of producing phototypic blocks, among which may be specially mentioned the method which is founded on the swelling of gelatine. These admirable phototypic blocks, which Mr. Dallas has lent me, are done by a method which he has perfected, but the nature of it has not been made public. Mr. Dallas was the first to introduce phototypic blocks into the English market, and if you carefully examine some of his specimens you cannot fail to be struck by the fineness and perfection of the details.

By the following modification of the swelled gelatine process I have succeeded in overcoming many of the difficulties of the methods already published.

We start with some clear sheet gelatine about one-thirtieth of an inch in thickness. This can be prepared by drying a layer of gelatine solution on a sheet of waxed glass, or it can be purchased from Mr. Cornelissen, of Great Queen-street. To make this gelatine sensitive to light it is soaked in $3\frac{1}{2}$ per cent. solution of potassium bichromate until it becomes flaccid, it is then laid on a piece of clean glass, and the excess of solution is removed by an application of the squeegee. The plate bearing the wet gelatine is then placed in a warm, and photographically dark, place to dry, and when dry it can be easily separated from the glass by raising one corner with a pen-knife. We obtain in this way a flat sheet of sensitive gelatine, having a smooth surface and all ready for exposure under the negative, and this exposure may last from 10 to 20 minutes in sunshine or a correspondingly longer time in the shade.

I now take the exposed film and put it into water to soak, and you will perceive that those parts which were protected from the light begin to swell immediately, while the exposed parts refuse to swell in the water. The soaking should last several hours, but as we cannot spare that time I will take a gelatine which has already soaked the necessary time, and make a cast from that. For this purpose I lay the wet gelatine film on a piece of glass, exposed side upwards, and squeegee it down as before; you see that it adheres to the glass quite easily, and after having made it surface-dry by dabbing with a soft cloth, a little oil is applied, and distributed over the surface. Now, that the excess of oil has been removed by a soft cloth, I pour on plaster of Paris to a thickness of about an inch, taking care to remove any air bubbles by the application of a camel's hair brush through the liquid plaster.

Now, this plaster will take about ten minutes to become solid, so let us take another one, which was cast just before the lecture, and which is now set. If we violently tear the plaster and the gelatine apart, the fine details of the cast are almost sure to be damaged. But instead of doing this, let us hold the glass plate in one hand, and gently push the plaster cast with the other. Now you see that the gelatine is slowly sliding over the glass, and finally it will slide quite off, the plaster still being adherent to the gelatine. It is now merely necessary to turn up one corner of the

gelatine film, and slowly fold it back so as to draw it off the plaster gently, and without fear of damage, either to the gelatine relief or the plaster, just as a lithographer draws a thin paper proof from the stone. The next step is to make a cast in stearine from the plaster, and for this purpose the plaster should be soaked in rather warm water, about 50° Centigrade, and on this soaked and warm plaster, just as I have it here, a layer of stearine about an inch thick should be cast. Such a cast takes a long time to cool, so I have provided myself with one previously done. There it is; see how easily the stearine separates from the plaster. I now dust the stearine cast over with bronze powder, the best being a kind specially manufactured by Mr. Allen, of Mansfield-place, Kentish-town; and, this done, I put the cast into the electrotyping bath, and when a sufficient quantity of copper has been deposited it is merely necessary to back up with type metal and mount on a wood block, as in the case of this example, our work being then ready for the typographic press. If the process I have described is gone through with an ordinary half-tone negative, an exceedingly beautiful electrotype is obtained, in which the gradations of light and shade are represented by varying degrees of relief. These, or even plaster casts, ought, I think, to have a very good sale, if photographers would only take the matter up. The ease with which they can be made is surprising.

I may mention that, instead of taking a cast from the plaster in stearine, gutta-percha may be used, a press being employed to force the plaster cast—which should be in an iron chase—into the soft gutta-percha. Here is a cast, and here a piece of soft gutta-percha. I now put them into the press, and apply pressure, and in a minute you will see what a good impression it is possible to get by this means. Of course, electrotyping on the gutta-percha is very easy, but the examples on the table will illustrate the matter sufficiently.

The depth of the relief obtainable by the swelled gelatine process is about equal to that of an ordinary visiting card, and, where large surfaces of white occur, it is necessary to deepen the plate in these parts. This may be done either by cutting out the metal from the finished plate, or, in most cases, more conveniently by raising the surface of the mould, let it be wax, stearine, or gutta-percha, on which the electrotypic copper is to be deposited. This is best done by holding a stick of stearine or wax in the left hand, and a warm pencil of metal in the other hand, and so holding the wax or stearine as to let a thin melted stream flow down the warm pencil. This stream is allowed to flow on those parts of the mould which require raising.

Most commercial phototypers content themselves with producing a very slight relief by photography proper, and they then deepen by hand work.

HEALTH AND SEWAGE OF TOWNS.

The following are some of the communications brought before the Conference, held on the 23rd and 24th May:—

THE EXPERIENCE OF ROCHDALE ON THE SECOND AND FOURTH SUBJECT ON THE PROGRAMME OF PROCEEDINGS.

By Alderman Taylor.

I.—*The Second Subject—"Gradual Abolition of Cesspools and Middens, and substitution of Tubs and Pails with speedy removal."*

The collection of excreta and house refuse in pails and tubs has been in operation, in Rochdale, for ten years. The rate of increase in the adoption of the pail, and so the gradual abolition of the cesspools and middens, will be seen by the following figures:—

March 31st,	1870,	there had been adopted	527 pails.
,,	1871,	,, ,, ,, ,,	543 ,,
,,	1872,	,, ,, ,, ,,	620 ,,
,,	1873,	,, ,, ,, ,,	819 ,,
,,	1874,	,, ,, ,, ,,	1,471 ,,
,,	1875,	,, ,, ,, ,,	761 ,,
,,	1876,	,, ,, ,, ,,	825 ,,
,,	1877,	,, ,, ,, ,,	798 ,,
,,	1878,	,, ,, ,, ,,	1,140 ,,
		Total pails	7,504

The borough was extended by the Act of Parliament in 1872, and now comprises 4,180 acres—being an extension of 3,004 acres. The district added to the borough rapidly adopted the pail system.

The population in 1872 was 45,224, and now in 1878 is 71,000. On the 25th January last, it was ascertained that there were still 1,200 old privies and middens, when the Health Committee of the Corporation, being fully convinced of the advantages and economy of the pail system, and the absolute necessity that the practice of "tipping" should be abolished, decided to recommend that the whole of the remaining old privies should be altered to the pail, and this, notwithstanding the satisfactory increasing voluntary alterations now being carried on.

The town, for the purpose of collection, is divided into six districts, named A, B, C, D, E, and F. Notice has recently been served on 80 owners of 163 privies in A division, to alter these to the pail system. Notice will immediately follow in B and the other divisions, and it is hoped that within the year the whole of the old privies will be abolished in the town. It might naturally be expected that considerable resistance would be made by the owners of the property, and in a few cases it may probably be so, but as yet there is a willing acquiescence. This state of mind is, no doubt, in a great measure, brought about by the clear advantages of the pail system; the tenant, the owner, the cottager, and the dwellers in highly rented houses, as also the millowners, are united in their approval, and no power would induce the people of Rochdale to resort to the cesspool, privy, or midden arrangements.

Looking at the heading of this subject, "The Gradual Abolition, &c," after the experience of the alterations of the old privies in Rochdale, one lesson we should draw and recommend, would be if the sanitary authority of any town began a similar work, it should require that the whole alterations should be completed within one year

This requirement might be, to some owners of property, very difficult to comply with, on account of the cost, but, to meet such cases, the authorities should themselves undertake the alterations, and allow the payment to be made by easy instalments.

The time of removal—one week—has not been altered.

II.—*The Fourth Subject—"Progress, if any, made in the Utilisation of Excreta since the last Conference."*

In a paper read at the last Conference, I stated that a machine for drying excreta, according to Mr. Firman's patent, would be erected in Rochdale.

There are now two machines at work, which reduce 14 tons of excreta as collected to 1 ton and 3 cwt. daily, to each ton of excreta there being added 25 lb. of sulphuric acid.

The following is a detailed analysis of the dried product by our chemist, Mr. Thomas Collinge:—

Insoluble silica	2·216
Lime	1·310
Oxide of iron and alumina	0·667
Sulphuric acid	1·885
* Phosphoric acid	3·102
Sulphate of potash	5·586
Chloride of magnesium	1·910
Chloride of sodium	5·120
Sulphate of ammonia	22·191
	43·987
† Organic matter	56·013
	100·000

The machines are 13 feet long by 4 feet in diameter.

The time required for drying varies according to the pressure of steam. With 60 lbs. pressure it requires about three hours and a half, and with 20 lb. five hours and a half.

This work is attained by our second machine, in which, though under Mr. Firman's patent, the faults of construction of the first machine have been avoided.

The quantity of excreta collected has risen from the average of the year of 124 tons, to 135 tons in the last two months, and we calculate that we shall reach 160 tons in the next 15 months, that is, when the town will be entirely on the pail system.‡ With four machines, the whole of the excreta may be dealt with, but it may prove to be more economical to have six machines, to allow sufficient time for repairs and for contingencies.

The cost of one machine, with boiler and engine, including patentee's royalty, is about £800; and of two machines, £1,400. After very careful calculation, the saving effected by one machine will be from £16 to £20 per week, or approaching £1,000 per annum, as compared with the cost of selling the excreta in an unmanufactured or partially manufactured state.

At present the manufacture is carried on in the centre of the town, but the Health Committee has decided to erect a third machine at the southerly side of the town, so that the cost of collection may be reduced. There is another site also contemplated on the northerly side.

Besides the excreta, the treatment and utilisation of the house refuse enters into the question, and requires notice. The average amount collected in the year has been 209 tons per week, and in the last two months 250 tons. We estimate that in fifteen months there will be 280 tons.

The cinders, and all vegetable refuse sifted and separated from the dust, &c., has supplied the requisite fuel for generating steam for driving three steam-engines (having 16 nominal horsepower), and for drying the excreta; but I may here state that if we increase our pressure of steam for drying, a little coal may be required.

The fine dust from the refuse we use for a lower class manure.

That part of the refuse which is not combustible, or otherwise saleable, such as pots, we grind up with the clinkers from the furnaces of the boilers, for making mortar, the quantity made this year being 914 tons, and a most excellent mortar it makes.

The butchers' and fishmongers' offal is added to the manure, the weight being about 8 tons per week additional to the excreta and refuse. Thus all our refuse is made use of profitably, and the requirements for a "tip," that disgrace to a town, done away with.

All the manure we make has met with a ready sale, and a great number of offered orders have been obliged to be refused.

The table below shows the yearly progress of the pail system. It may be well to observe that the year is reckoned from April 1st to March 31st. The effect of manufacture and non-manufacture, in increasing or decreasing the cost, is at once

Year ending March 31st.	No. of closets.	Collected		Manure		Houses.	Mill and workshops.	No. of persons using the closets.	Gross expenditure.	Gross receipts.	Net cost.
		Excreta. Tons.	Ashes. Tons.	Made. Tons.	Sold. Tons.				£	£	£
1870	527	398	611	377	217	1,048	12	5,797	694	537	157
1871	1,070	846	1,521	1,059	699	2,944	31	11,770	1,538	1,380	158
1872	1,690	1,431	2,405	1,566	1,019	3,174	39	19,283	2,392	2,167	225
1873	2,509	1,989	3,413	1,989	412	4,560	69	26,984	3,463	2,826	637
1874	3,980	3,516	5,196	3,497	1,543	7,287	106	43,500	5,284	4,449	835
1875	4,741	4,224	7,650	3,741	2,002	8,487	123	50,000	7,057	4,420	2,637
1876	5,566	5,290	8,483	755	2,040	9,433	146	52,000	9,354	860 626	7,868
1877	6,364§	5,643	9,277	410	1,136	10,443	162	54,500	13,407	771	12,635
1878	7,504§	6,372	10,914	728	923	11,963	189	61,000	11,521	2,252	9,269

* Equal to 6 771 tribasic phosphate of lime made soluble.

† Containing 3·083 nitrogen, equal to 14 534 sulphate of ammonia.

‡ This does not include the urine from the urinals, which will also be treated in a short time by the machine, and when our machinery is extended and our arrangements a little more complete, attention will be given to increase the per-centage of phosphates.

§ Increase, 1,140, of which 379 were for new houses—10,000 still using old privies.

seen. In the years 1876 and 1877, there was practically no manufacture, the value under the heading gross receipts being chiefly for the crude mixture of night-soil and ashes. In 1878 the manufacture of manure has again commenced, but not through the entire year.

It is worth stating that in the process of manufacture there is no nuisance.

AN ACCOUNT OF THE SEWERAGE AND IRRIGATION FARM AT BEDFORD.

By George Hurst.

In a thickly-populated country like England, the uniform removal of offensive matter from the dwellings is of immense importance. The health, comfort, and decent habits of the inhabitants are mainly preserved by the regular removal of excreta and other impure feculent accumulations from their habitations. For such salutary purpose no method that has hitherto been devised has succeeded in an equal degree with the water-closet system, combined with well-arranged sewerage, and a proper disposal of the effluent contents. Yet many towns are still deficient in sewage appurtenances, and pollute their brooks and rivers with the noxious refuse of their imperfect drainage. It becomes, then, important to inquire respecting the sewage contrivances of such places, where they have been already most elaborately and successfully executed, with a due consideration in what respect they may have been imperfect, with suggestions for improved methods, the expense of their construction, and the average cost of their maintenance.

In the town of Bedford a system of water, sewage, and irrigation works has been in operation for the last 10 years, which has been attended with satisfactory results. Previously, some imperfect drains polluted the beautiful River Ouse, and the greater part of the houses had offensive middens and cesspools. The town is in many respects unfavourable for drainage, lying low in the Ouse Valley, and being deficient in declivities. The fall in the lower parts is very limited, but the disadvantages have been successfully surmounted. The plan consists of a main sewer into which, from all parts of the town, lateral drains are discharged, and at the terminus of the main sewer it empties itself into a tank 16 feet deep, so that an artificial fall is obtained, from which it is pumped up, and distributed by pipes over the irrigation farm, which consists of about 180 acres. The pumping and irrigation works are distant a mile from the town.

The population of the town is about 19,000, and from the waterworks receives daily 350,000 gallons of water; the greater part of this, of course, passes from the houses and streets into the sewers, which, in addition, take a considerable quantity of subsoil drainage, making together about 700,000 gallons daily to be pumped up, and distributed over the farm. So much of the subsoil drainage passing into the sewer is owing to the main drains not having been made water-tight, which is certainly a defect, for a subsoil drain, and a sewer, when properly constructed, are not convertible. The sewers are intended to convey offensive fluids and excremental matter from our habitations, the ultimate disposal of which, and its transformation to an innocuous state, has been considered a question of difficult solution. The subsoil drain is intended to convey from the land the surplus water that it may receive, and it may properly be discharged into and supply the regular water-courses.

So large a quantity of water passing into the sewers causes the manure to become excessively diluted, and, as a liquid manure, it does not contribute so much richness to the soil as many suppose; and what fertilising matter it does impart to the land, is soon exhausted by the rapid vegetation. The great value of the irrigation is not so much for the solid matter held in solution, as maintaining a constant and sufficient supply of moisture in the arid seasons. So far from land irrigated with sewage becoming surcharged with manure, to keep it in good condition it will bear a considerable quantity of solid in addition.

A subsoil drain should be made of porous bricks or tiles, to allow the water to percolate through them, so as effectually to carry off the moisture with which the ground may be overcharged; but a sewer should be perfectly water-tight, as the quantity of water thrown down our closets, and discharged after domestic usage, will render the contents of our sewers sufficiently fluid. Beyond this, for purification or clearing away obstructions, occasional flushing will accomplish all that will be required.

The land, being near the town, is heavily rented. In such situations it is everywhere let at, what is called, accommodation price, being often required for purposes which are not expected to yield a direct agricultural profit, The average rent—it is rented of several landlords—is about five pounds per acre; but it is very suitable for the purpose, being on a bed of gravel, and the sewage water is rapidly absorbed by the soil. Excepting in very rare instances, no unpleasant smell can be observed on going over the farm, as the sewage, passing immediately into the ground at once, becomes deodorised.

The sum expended in engineering works, buildings, pumping apparatus, and embankment was £25,000, which was borrowed, to be repaid with interest by half-yearly instalments running over 35 years. It would be unreasonable to expect any portion of this sum to be obtained from the profits of the cultivation, as although directly paid out of the rates, the public is fully remunerated for the outlay by the important benefits conferred. Previously to the establishment of the sewage works, each housekeeper was at considerable expense in the removal of the offensive refuse matter, which may be considered a fair set-off against the increased assessment, besides the improved healthiness of the town, and its having a clear magnificent river flowing through the town, instead of a stream turbid with various pollutions.

The production of the land has been extraordinary, and it is admitted that on no irrigation ground have more luxuriant crops been obtained. The Italian rye-grass, mangel-wurzel, and cabbages have been a great success, and the root crops generally have been distinguished for obtaining prizes at many agricultural exhibitions. Potatoes, parsnips, and other succulent crops have been cultivated with equal success. The produce has been sold by auction, and has generally realised good prices. For a public body this method of

disposing of the crops is, perhaps, the most satisfactory, although a private individual might possibly turn them to better account.

During the last two or three years farming has been generally unremunerative, and the Bedford farm has only paid the rent and expenses of cultivation; but this has not been doing amiss, considering the charge for rent—altogether £928 10s. per annum. For irrigation cultivation, a dry season must always be the most successful. Italian rye-grass and roots being the principal crops, and the demand being at such times very considerable, good prices are always realised. The produce sold by auction, and privately by the manager, amounted altogether in the year ending last December to £1,751 10s., and in addition a portion of meadowing was sublet at a rental of £119 17s. In favourable seasons we may fairly calculate upon obtaining, with all our disadvantages, a considerable profit.

In the tank, rags, paper, and other solid articles are intercepted by a simple grating; and the sewage is then pumped into a cast-iron tower seven feet in diameter and twelve feet in height, from which, by gravitation, it is distributed over the farm. It is first conveyed through covered piping to the land, and over twenty acres along ridges by a 9-inch half-round drain-tile, which is sunk into the ground. The ridge is twelve inches above the furrow, and the sewage water running over the tile sinks into the land, very little reaching the bottom. The other fields are less carefully laid out, but are watered in like manner from surface furrows along the higher lines; heavy crops are regularly grown.

The effluent water percolating through the banks on the side of the land is perfectly clear and tasteless, and, so purified, passes into the river.

Two engines, of 12 horse-power each, and two centrifugal pumps, are employed at the pumping works.

The length of the main sewer exceeds a mile and a half, sufficiently capacious to serve as a reservoir during the night, and has a storm-overflow, with a self-acting flap. An excessive rainfall will pass without trouble in the night into the river.

Waterworks.

To complete the sanitary arrangements of the town, waterworks were indispensable, and accordingly formed part of the system. A good supply of excellent water was obtained by sinking a well about half a-mile distant, 40 feet deep in the oolitic limestone. This water is thrown up by pumping into a covered reservoir at the top of a hill in the neighbourhood, and is raised 170 feet above the general level of the town, and gravitates through pipes to supply the inhabitants. The pumping is performed by two engines, which work alternately; one is nominally of 40 and the other of 60-horse power.

The cost of the waterworks, piping, and all appliances connected therewith, amounted, in the first instance, to £19,600, but various additions and extensions that have since been made have increased the expense incurred to £24,000. This outlay, although it may seem large, considering the extent and importance of the works, has been very economically carried out, and has been a lucrative investment. At this time the gross income per annum derived from them is no less than £2,028, which leaves a fair profit after deducting the interest of the capital, £1,080, and £700 working expenses.

The expense of these works has necessarily caused a considerable increase of the rates, and will continue to do so, until the repayment of the loans shall have been completed, when a permanent benefit and fixed capital will be secured. The cost is by no means to be regretted, as the advantages are more than commensurate with the outlay. The comfort of the inhabitants being greatly improved, and the healthiness being permanently secured, the mortality of the town, according to the last returns, was little more than 19 to the 1,000 of the population, which is below the average of the country.

Dr. Prior, the Medical Officer of Health, in his report for 1878, remarks that,—

> "Bedford has now reached a point at which it has come to be regarded as one of the best sewered, best appointed, and most healthy and agreeable towns of England. It is visited for the purpose of obtaining particulars as to its management by many strangers—sometimes from foreign countries."

ON THE NECESSITY OF FURTHER SANITARY LEGISLATION, AND THE PROGRESS, IF ANY, MADE IN TREATING WATER-CARRIED SEWAGE.

By C. N. Cresswell.

In the programme of proceedings of this, the Third Annual Conference, we are asked, "Whether any further legislation of a compulsory or permissive character is needed for bringing about a better sanitary condition of towns and dwellings?"

In my paper of last year there were two suggestions, which seemed to meet the approval of the Conference, viz.:—

1st. The importance of introducing the ballot in local board elections, in order to counteract the arbitrary interference of cottage landlords.

2nd. The need of county health inspectors, with such emoluments as to render them independent of parochial influences in the performance of difficult duties.

The President referred to the subject in the course of his final address, remarking that, at the next Conference, "a limited time should be given to the discussion of legislative reforms," and that it would be well for the members, during the interval, to "make themselves as fully acquainted as possible with the existing law," as there was a "great deal of sanitary law not availed of."

The whole subject of local government elections being at this moment before Mr. Hibbert's Committee of the House of Commons, we are bound to await the result of their deliberations.

With regard to the appointment of county inspectors, or superintendents, the Government has, as yet, made no sign. Possibly, it requires the stimulus of public discussion at this Conference. Meanwhile, in treating of the need of still further legislation, a large and complex subject, it will save much time and unprofitable argument to follow another recommendation made by the President last year, and "write a paper in lieu of a speech."

In the 4th and 5th paragraphs of the programme we are invited to discuss "Progress, if any, made since the last Conference."

Where is the evidence of any real advance whatever during the past 50 years? There has been much talk, a multitude of councillors, periodical alarms, spasmodic efforts, scientific congresses, sanitary conferences, a general awakening to a sense of something defective; but the tangible results have not been even commensurate with the growth of population. On the contrary, the mischiefs of overcrowding, and the accumulations of a generation, have outstripped the tentative measures of sanitary reformers, and left them panting, halting, and discouraged in the race far behind. Our byeways may be cleaner, and the atmosphere of some towns purer, yet this has been gained at the expense of others to whom we have transferred the nuisance, changing only the *venue* without abating the evil.

It is but a short while since town and country alike disposed of its refuse on the spot, by means of middens, cesspits, and precarious dust-carts, while the earth performed the kindly office of concealing and, in a measure, converting the products of organic decay.

Water-closets soon filled the cesspits to overflow, and augmented the volume of pollution in populous places, until surface-drains were choked with filth, and the saturated soil reeked with abominations. Every wayside ditch became a conduit of diluted sewage, diffusing the mischief over a wider area, and transmitting the sulliage of each household to the precincts of others less favourably situated below it. From wayside ditch to watercourse, from watercourse to stream, is but a short step, and in 1861 the Royal Commissioners reported that "the sewage of one town had become the water source of another." This primitive process of indolent unthrift and neglect has culminated in that which is now known as "the sewage difficulty" over the length and breadth of the land. *Monstrum horrendum, informe, ingens!* It has as many heads as the hydra, and confronts us still with unabated horrors. Here, indeed, is water-carried sewage with a vengeance, and it is asked what progress has been made (if any), since the last Conference, in grappling with it.

There has been a redundance of legislation, embodied in a tortuous series of enactments. To wit:—

The Public Health Act of 1848.
The Nuisance Removal Act of 1855.
The Local Government Act of 1855.
The Sanitary Act of 1866.
The Sewage Utilisation Act of 1867.

Finally, the whole consolidated, amended, and defined in 1875.

Legislation has dragged its slow length along while events have galloped with portentous haste, and neither imperial nor local effort keeps pace with the needs and expectancy of the nation. In 1876, popular excitement induced a palliative measure in the Rivers Pollution Prevention Act, but that measure has failed of its purpose, and given to wrongdoers a quasi-legislative sanction for their delinquencies and incapacity. At the same time, the Thames Conservancy Acts of 1857 and 1867, after much ado about nothing, have suffered a palsy, and received their *quietus*—for a time, at least—in the Lower Thames Valley Drainage Act of last year. In the meantime, a cry has gone up for water—water for the food and ablutions of man as well as the requirements of our great staple industries. Every river, from the Tay to the Dart, has been contaminated with the refuse of homestead or factory. The salmon kelts of Westmoreland and Cumberland are in process of destruction by a parasitic fungus plant, the newest development of sewage pollution; and, while professors dispute as to final causes, and means of prevention, the patient public waits for the *Deus ex machinâ*, in the form of some miraculous intervention, to save them from the natural consequence of their own apathy and ignorance. In presence of these and other startling phenomena, where shall we seek the signs of progress, or compute the net results of practical sanitation?

The national anxiety finds relief in a popular cry; that form of generalisation so acceptable to shallow minds, inasmuch as it relieves them of the pain of thinking for themselves, and saves time by precluding argument.

Centralisation, it is said, is the fountain source of these sanitary shortcomings, and it is above all things needful to revivify the civic life and vigour of the people, in order to resist the centripetal tendencies of our time. It is but a half-truth after all; for the action of a central authority is as necessary to the body-politic, as the motive power of the heart to the circulation of the human system. Nevertheless that action may be strained and abused, as we see too plainly in the modern tendency towards meddling and muddling with subordinate authorities in matters beyond the scope, and outside the functions of imperial control.

In this respect it may be expedient to reorganise the Local Government Department, and re-adjust it on its own proper bearings. Further legislation in this direction will rid us of that red-tape and circumlocution which encompasses every limb, and paralyses the functions of local bodies, reducing independent self-government to the shadow of an empty name. From the investigation of a grand scheme of arterial drainage to the contents of a workhouse plum-pudding is a wide range of official supervision, yet nothing is too large or too minute for the elephantine prehension of the Whitehall department. There is a veritable plague of inspectors abroad, and the native stubbornness of the provincial mind, although it may need the spur and impulse of the central authority to set it in motion, resents this constant yoke of official supervision, which will not permit the expenditure of a few pounds, or the construction of a workhouse pig-stye, without a local inquiry and departmental sanction.

This was not the intent of those who framed the Public Health Acts, nor is the system compatible with the divine right of self-government. The functions of Imperial administration end where those of local self-government begin; each has its proper uses in the economy of the State; and there is scope enough for each within its own particular province. The Rivers Pollution Prevention Act is in point. Such is the superfluity of safeguards and precautions in the provisions of that Act, that none save a Government department would venture to put it in force—nor can a

sanitary authority take any proceedings under it without the consent of the Local Government Board. Here, then, was a field for the energies of Government, where both the resources and influence of the State might be usefully employed.

Yet nothing has been done to enforce or direct the operation of an Act which is, as it were, stillborn, and truly a most lame and impotent piece of legislation! On the contrary, we can cite cases where local enterprise has been hampered; and official interference has blunted the edge of many a bold resolve on the part of those who have striven humbly but honestly to help themselves.

Reading and Oxford have been permitted to embark with a light heart upon a grand experiment of sewage utilisation, because the method of disposal coincides with the Procrustean theories of the Local Government Board. According to the rigid formula now in vogue in high places, every authority is required to fit the same bed, and conform to the same standard, without regard to local conditions, or the measure of local resources. If we appeal for aid and light to the great central luminary, it makes but one sign; and recognises but one shibboleth in the darkness. Irrigation is their grand climacteric; and as all roads lead to Rome, so all official intervention tends in one direction. If the Government be right, this is the be-all and end-all of sanitary progress, and the Conference may dismiss all other modes of treatment as irrelevant and futile. It is a gloomy prospect for the Lower Thames Valley; where the suggestion sounds like a sorry jest, and land consists of tennis-lawns and croquet grounds relieved here and there by paddocks at a rent of £50 per acre per annum. In this quarter, "union of districts" is the latest development of sanitary enterprise, but the conception is still in the process of gestation, and when brought to maturity may prove to be a monster of terrible import and insatiable appetite. At present it is regarded with more sympathy by engineers, than by the ratepayers concerned, and, despite the favourable augury of official approval, their minds are disquieted within them.

The town of Ashford, Kent, has long been in labour with a project of sewage disposal, and after much investigation resolved to adopt a process of precipitation. Upon application to the Local Government Board, they were informed "that no system of purification by means of chemicals would enable them to dispose of their sewage satisfactorily, or produce an effluent fit to flow into the river;" and of course filtration over land was the alternative suggested.

Whether "land at a reasonable price can be procured with favourable natural gradients, with soil of a suitable quality and in sufficient quantity" (to quote the words of our own report in June, 1876) is a problem yet unsolved. At all events Ashford remains undrained to this day, and we must look elsewhere to find "progress, if any, in treating water-carried sewage."

Berkhampstead is in like case, and received a like reply, viz., "that chemical precipitation is insufficient, and must be condemned."

Salisbury has fared no better; and to the appeal of Trowbridge for help in their trouble the Delphian oracle replied, "There is no other system which will render sewage effluents pure than irrigation over land."

It may be true as an abstract proposition, but it is cold comfort to Salisbury and her sisters in distress, a long catalogue of towns, as Worcester, Stafford, St. Albans, Brentford, Isleworth, *cum multis aliis*. In the meantime, Aylesbury has overcome its difficulties by means of precipitation, and the townships of West Herts would fain imitate the example, seeing that the Aylesbury Board of Health passed unanimously a resolution, on the 14th January last to the effect "that they are perfectly satisfied with the mode of treatment adopted for the disposal of the sewage of their town."

Whether West Hertfordshire will be permitted to govern itself in this matter is doubtful, since the Local Government Board adheres to its official utterances, "that the only effectual modes are filtration through land, or irrigation over land;" and, again, "there is no process by which sewage can be so purified in tanks as not to ferment."

This latter assertion, made in May, 1877, a few days after the close of our Sanitary Conference, is at variance with the scientific authority of such men as Angus Smith, Keates, Letheby, Crookes, and with the experience of many of us in this hall. Moreover, it conflicts with the recorded conclusions of the Blue-book of July, 1876, and the Report of our Executive Committee, dated June, 1876, embodied by the Government in their own Appendix, where it is reported for our guidance that, "with regard to the various processes of subsidence, precipitation and filtration, it is evident that by some of them a sufficiently purified effluent can be produced for discharge, without injurious result, into water courses and rivers of sufficient magnitude, &c." Here we have the opinion of experienced men in language clear, concise, and convincing, yet the Government declines to quit the grooves of its antiquated traditions, and commits itself to dogmas with a pertinacity worthy of the Roman Syllabus.

So long as this is the condition of the official mind, there can neither be hope of progress nor "a better sanitary condition of towns and dwellings." These periodic Conferences will be labour in vain, and the assembly of practical sanitarians, from all parts of the kingdom, can lead to none other result than a record of defeated schemes, disappointed enterprise, and universal stagnation.

One is tempted to inquire—for what great purpose the Local Government Board has been constituted, when applications for advice are met by common forms, savouring more of the retort courteous than official encouragement. "The Board cannot, under the circumstances, advise the authorities of ——" Or "Referring to the subject of your letter, the Board declines to express an opinion. , . . . &c."

There is, however, a ray of light in the darkness. The Bill now before Parliament for the constitution of County Financial Boards, or Local Parliaments in every county, promises to unloose the deadlock of sanitary administration. The complex machine creaks upon its hinges, but a new lever is forthcoming to help on the work.

These County Boards should do the work of local supervision, not only sanctioning loans, but granting them out of local funds contributed

within the district, and secured by the best of all safeguards, viz., the resources of the immediate district, developed and improved by the expenditure of moneys so obtained. The power to authorise the purchase of lands for sanitary objects —at present only attainable by an Act of the Imperial Legislature—if conferred on these new constitutions, would relieve sanitary authorities from the elaborate procedure of the Lands' Clauses Act, while the utilisation of local resources would put a stop to that drain on the national exchequer which has already excited alarm in high quarters. Those who furnish the means, and those who sanction the outlay, would alike be on the spot to watch and control the work, and thus, in lieu of local government in leading strings, hampered by perpetual inquiries, adjournments, delay, taught to look to Jupiter rather than self-help, and leaning too often on a broken reed, we should at length realise that kind of authority which our President foreshadowed from his place in Parliament as having "vitality, cohesion, adaptability, strength enough to resist the centralising tendencies of the day," and providing a means of political education for all classes of the people.

There are enough questions to occupy the time and attention of superior authority at Whitehall. The Pollution of Rivers Act, the investigation of scientific processes, the definition of new areas, and simplification of old, the collation of statistical data in order to determine the course of future legislation, these and cognate subjects appertain to imperial administration, and would enable the department to regain its proper sphere of usefulness. It is because the latest measure of Government has been conceived in this spirit, and is capable of still wider development in this direction, that it deserves the earnest support of the Conference; and we trust that members will not separate without recording their approval of the general scope of the Bill, thereby strengthening the hands of its supporters in and out of Parliament.

Having thus indicated the need of further legislation in three particular directions—

1. The protection of the ballot in the election of members of Local Boards, in order to counteract the influence of small tenement proprietors, always and everywhere the interested opponents of sanitary progress.

2. The appointment of medical superintendents in each county or division of a county.

3. The first great step towards decentralisation by the constitution of County Boards, so as to habituate the people to self-government, and prepare them for the eventual introduction of provincial Parliaments.

I have yet to mention another indispensable factor in the work of bringing about that "better sanitary condition of towns and dwellings," which is the real aim and object of these Conferences, viz., a loyal resolve on the part of all concerned, whether governors or governed, to do the work which they have undertaken to do. Local authorities do not move unless there be pressure from without, as well as from within. It is not in the nature of such bodies to initiate improvements, *mero motu*. Their bent and tendency is one of resistance to all reforms which involve a possible increase of the rates; nor can we recall a single instance during the past twenty years, where a corporate body has volunteered to improve the conditions of things around it, except the courts of law had applied the spur to the flank of their lagging energies. Sanitary progress is a monotonous tale of injunctions granted, or informations filed, at the instance of individual inhabitants, for the abatement of nuisances which the corporate authorities had suffered in silence, connived at, or ignored; and the reason is obvious, viz., that the Boards consist in great part of the principal delinquents, or their satellites. Even Parliament is not proof against the canker of vested interests, and legislative measures "of great pith and moment their currents turn awry" by reason of timid acquiescence or untimely concessions.

The opposition of the Metropolitan Board of Works to the Rivers' Pollution Prevention Act was disarmed by the introduction of clauses specially exempting the chief offender from its operation. Upon what principle, logical or sanitary, is the noblest river of the kingdom thus doomed to perpetual defilement, and the metropolis of civilisation set above the law of the land, like the old "benefit of clergy" in the days of the Plantagenets? Is it that the enormity of the dereliction takes the case out of the category of sanitary measures? or that a right to foul its own nest has vested by prescription in the City of London? The right of pollution, and the impunity of wilful waste in this case is the creation of the Legislature, and a political compromise. In others, it is the result of sheer apathy and ignorance combined. It is otherwise in the North, where Manchester and Halifax, Rochdale and Leeds, are grappling boldly with this pollution, and Professor Ansted has shown us, that it is more economical to keep excrementitious matter out of drains, than to separate the diluted sewage at the point of outfall. If, however, it be found impracticable in our large towns to dispense with water as a vehicle for removing fæcal refuse, can we not learn a lesson from the analogy of nature and the physiology of the human frame? Solids and fluids are poured into the same gullet, and commingle in the same vessel, yet they are separated again before discharge by the secreting organs of the animal body; which things are an allegory not unworthy of the attention of the metropolitan authorities, who were careful, by their Act of 1858, both to acquire the powers of taking lands for deodorising sewage, and to define "deodorise" as including the separation of "solid suspended matters in sewage" from "the liquid before the discharge thereof." It is strange that nothing has yet been done to give effect to these important clauses; but, says Mr. Norman Bazalgette, the doughty champion of the new philosophy of waste, "The cost will be enormous, and the process a nuisance." We admit the cost, but categorically deny the nuisance. As to the first, it is a question of comparative evils; as to the latter, we have abundant evidence in refutation. Take, for instance, Leeds, which, at considerable cost of money and experimentation, has ascertained the best available method of defecating its sewage, and possesses, if only it be willing to employ it, the means of passing without nuisance a comparatively pure effluent into the river. But the stream flows by still foul and fetid as ever from the upper reaches,

changing its hue with each particular dye, and polluted with the refuse of tanneries and cloth factories. What is the use then of defecation at Leeds, even if the effluent were as Apollinaris water itself, where all salutary effects are lost in a mass of filth pouring down from the towns above it? and what is the resulting advantage of exacting compliance with sanitary laws from one town, while permitting others to pollute the same stream in a geometric progression of filthiness through its whole course above and below? Surely this is matter for the intervention of the Local Government Board, if it be minded, in all loyalty and thoroughness, to do that work which the Government alone effectually can do. The energy of Leeds should be supplemented by fearlessness and impartiality at head-quarters, whence the impulse must come, if we may ever hope to realise the end of sanitary legislation. Ten righteous men, we are told, would have saved Sodom. If even one of our rivers throughout the length and breadth of the land has been rescued during the past year from abomination, it will be an answer to the query set forth in our programme, and we shall not be without encouragement for the future. *O fortunati nimium!* if any delegates present can point to so desirable a consummation.

Even in the reign of Henry VIII., an Act was necessary to prohibit "the annoying of the stream of the River Thames by casting of dung, rubbish, or other thing in the same river." The statute, however, did not prevent a long succession of pestilences, and it remained for the Great Fire of 1666 to thoroughly disinfect the plague-spots of the metropolis. In 1667, the first urban sanitary Act was passed, and provision made for the construction of sewers, or rather "fresh water trenches," which it was a misdemeanour to pollute by house drainage or other offensive matters. We owe to the visitation of the cholera at a later epoch the tardy inauguration of a system of sewage disposal by water carriage, which has produced a fresh type of zymotic disease traceable to sewage sources, but especially to the vicious construction of houses, whereby typhoid fever is laid on with the same precision as hydrocarbon gas for the purposes of illumination.

Dr. Murchison has distinguished this new revelation from its prototype typhus; and Dr. Fergus has proved abundantly, that in Glasgow, where it has raged at intervals from the year 1836, it arose from a badly-constructed system of flushing by water; but whatsoever be the *fons et origo mali*, that town has decided that it would be tempting Providence to wait supinely for another portent, and appears at last to be in earnest in the attempt to set its house in order. River pollution is a vital question, concerning both the health and food of the people, and let us hope that before the census of 1881 shall have told its tale, we may have achieved something to avert the recurrence of a national pestilence.

ADDITIONAL INFORMATION RESPECTING WATER-CARRIED SEWAGE TREATMENT.

By J. C. Mellis, C.E.

Having upon two previous occasions contributed a short account of the treatment of the sewage of Coventry, it may not be uninteresting to record, after another year's experience, that the method adopted there still continues to merit the success which it had already obtained.

The Corporation now lease their work to the Rivers Purification Association, who, for an annual subsidy paid to them, relieve the Corporation from all trouble, and undertake the whole work and responsibility in connection with the sewage, an arrangement which appears to afford complete satisfaction to the Corporation, to the landed proprietors along the banks of the River Sherburne, and to all others whose interests are concerned. It appears worthy of notice that each year's experience has the effect of reducing the cost of dealing with the sewage. This is brought about in various ways, but perhaps chiefly through improvements in the method of manufacturing the chemicals employed. It will, doubtless, be remembered that the works at Coventry included several buildings and a large amount of machinery for drying the sludge into a portable manure by artificial heat. This is not now found desirable, as the sludge is sold or disposed of in the immediate neighbourhood of the works in a similar condition to farmyard manure, and, to bring it into this condition, presses are about to be employed instead of the drying machine; a model of one of these presses will, I understand, be shown amongst the sanitary appliances at the Society of Arts Exhibition this year. These alterations will dispense with some £4,000 worth of buildings and machinery, which are now no longer in use at the Coventry works. As some of these changes have only very recently been put into operation, it may be as well to defer for another year giving the reduced cost of working, when accurate accounts can be supplied. It has upon former occasions been stated that Coventry is representative of a thoroughly manufacturing town, so far as its sewage is concerned, and does not afford data for a direct comparison with towns having domestic sewage. Information relating to domestic sewage may, however, now be obtained from the town of Hertford, where the same process is in operation, and where the sewage is of a domestic character. The Corporation of Hertford have made a contract similar to the Corporation of Coventry, and the following particulars of the treatment of the sewage of this place, I think, may be useful.

Hertford is situated on the River Lea, whence the New River Company derives its water supply, and purification of the sewage needs to be efficiently accomplished; the population is 7,169. The average daily flow of sewage, owing to a very large leakage of subsoil water into the sewers, was once as high as 1,640,000 gallons, but is now estimated at 1,000,000 gallons, or 140 gallons per head of the population. Water-closets are in general use.

From the year 1858 to 1875, the sewage was subjected to the lime process, and then was dealt with for a time by the Phosphate Sewage Company, under the impression that a valuable manure would result from its treatment. These expectations were not realised, and a short time ago, the lime process was reverted to, but failed to accomplish the requisite degree of purity, and the Coventry process replaced it. The works are exceedingly simple, and the effluent water, after chemical treatment, is passed through a tificial

filters instead of through land as at Coventry, there being no land available.

MISCELLANEOUS.

MUSIC IN PUBLIC ELEMENTARY SCHOOLS.

Sir Charles Dilke having moved for a "copy of all memorials sent to the Education Department on the subject of Musical Instruction in Public Elementary Schools, and the answers made thereto by the Department," a return has been made and printed by the House of Commons.

No. 1.—MEMORIAL OF THE CLERGY RESIDENT IN AND NEAR MANCHESTER.

To the Right Honourable the Lords of the Committee of Council on Education.

The memorial of the clergy resident in and near Manchester, respectfully sheweth,

1. That your memorialists are of opinion that the national cultivation of Music for the due performance of religious services, and for promoting general education and the culture of the people, is deserving of the encouragment of the State, as in Germany, France, Belgium, Italy, &c.

2. That, in the first instance, it appears to your memorialists desirable that efficient instruction in Music should be given in elementary schools and night classes, for which special teachers, having musical ability, should be trained, and that the schools should be examined, and prizes given, according to the system already established in other subjects of science and art.

3. Your memorialists express a hope that the subject may receive the favourable consideratiou of the Lords of the Committee of Council on Education.

(Signed) J. MANCHESTER,
Bishop of the Diocese,
And by 102 clergymen resident in or near Manchester.

No. 2.—MEMORIAL OF THE MANCHESTER DIOCESAN BOARD OF EDUCATION.

To the Lords of the Committee of her Majesty's Most Honourable Privy Council on Education.

The memorial of the Manchester Diocesan Board of Education respectfully sheweth,

That, in the opinion of your memorialists, it is desirable that additional encouragement should be given to teaching of vocal Music in elementary schools, as being a means of cultivating the musical tastes of the people, and so tending to promote their moral and social elevation.

That, at the present time, in the majority of elementary schools, singing is taught only by ear, the words and music of the requisite number of songs being learnt, but no attempt being made to cultivate part-singing, or to teach the art of vocal Music according to any definite method.

That, in order to supply this want of efficient instruction in Music, it is necessary, in the first place, that competent teachers should be provided, and that a system of examination should be instituted to test the instruction given.

Your memorialists would suggest that one means of accomplishing this, is by placing Music on the list of subjects for which grants are made and certificates given by the Science and Art Department, thus affording the same facilities and encouragements for the teaching of Music in elementary schools as are afforded for the teaching of drawing.

And your memorialists will ever pray.

(Signed) J. MANCHESTER,
President.

14th May, 1878.

No. 3.—FORWARDED BY THE LANCASHIRE ASSOCIATION FOR THE CULTIVATION OF MUSIC AMONG ALL CLASSES.

National Cultivation of Music.

At a meeting of the clergy, held on the 30th of January, 1878, at Manchester, at which the Bishop of Manchester presided, a committee was formed, for the purpose of securing more efficient instruction in Music in elementary schools, and promoting the training of teachers. In accordance with the request of the committee, the Rev. Dr. Burton and the Rev. E. Preston Anderson submitted for approval the following graduated system, and it was ordered to be printed for general consideration:—

Suggested Musical Grades for Elementary Schools.

Grade I.—Vocal music by ear, as taught at present for the Government grant of a shilling per head.

Grant II.—Musical nomenclature, viz., the use of the staff or stave, treble and bass clefs, sharps, flats, and naturals; and forms of notes, rests, and bar lines.

Grade III.—Scales, major and minor in the open key. The dot, accidentals, different kinds of time, together with a knowledge of the following marks of expression:—*ff, f, mf, pp, mp, p, crescendo, diminuendo, sf,* <, >, <>, and *roll.*

Grade IV.—Intervals.—To sing a simple melody in the open key; to understand such words as *Grave, adagio, largo, allegro, andante, moderato, presto, tempo.*

Grade V.—The scales of G, D, F, and B flat, major, with their relative minors. To sing simple melodies in these keys; and a knowledge of the following forms, viz., chant, hymn tune, CM., LM., and SM.; and the meaning of the words solo, duett, trio, quartett, chorus, melody, and harmony.

Grade VI.—The keys of E flat, A flat, A and E major, and their relative minors. To sing simple melody in any key. To understand the meaning of the words anthem, sanctus, oratorio, opera, glee, part-song, madrigal, &c., together with the names of some principal composers in each department.

GUS. M. BURTON, Rector of All Saints', Chorlton-on-Medlock, Manchester.
E. PRESTON ANDERSON, Curate of S. Gabriel's, Hulme, and Precentor of the Manchester Gregorian Choral Association.

Manchester, 3rd April, 1878.

No. 4.—MEMORIAL FROM THE SCHOOL BOARD OF BALFRON, STIRLINGSHIRE.

Unto his Grace the Duke of Richmond and Gordon, Privy Council-office, London.

The following memorial from the School Board of Balfron, Stirlingshire, humbly sheweth,

That your memorialists are deeply sensible of the great importance of musical instruction in the schools throughout the country; that at present, while the Government grants a shilling a-head where such instruction is afforded, no encouragement is given where excellence is attained; that consequently neither teachers nor school boards are sufficiently interested in seeing that the children receive more than the simplest elements of musical training, and that even these are in many instances imperfectly taught.

Your memorialists, therefore, trust that the Government may be induced to fix some standard of efficiency,

such, for example, as sight-singing as distinguished from singing by ear, whereby a small remuneration may be given to those schools in which the musical instruction is of a superior quality.

In name and by appointment of the School Board of Balfron.

(Signed) ROBERT SEWELL, Clerk.

No. 5.—MEMORIAL OF THE SCHOOL BOARD FOR THE DISTRICT OF THE CITY OF MANCHESTER, TO THE LORDS OF HER MAJESTY'S MOST HONOURABLE PRIVY COUNCIL ON EDUCATION.

The memorial of the School Board for the district of the city of Manchester, respectfully sheweth,

That, with a view to the improved teaching of Music in public elementary schools, it is desirable that Music be placed on the list of subjects encouraged by the Science and Art Department, and made specially applicable to pupil and assistant teachers, with a scale of grants similar to that specified for results in drawing; and your memorialists would urge that a great impetus would also be given to the popular study of vocal and instrumental Music on scientific principles, were a scheme elaborated whereby certificates (similar to the "D" drawing certificates) could be obtained by teachers desirous of earning money by giving instruction in Music in both its branches, with provisions for a partial certificate for either vocal or instrumental Music similar to the provisions with regard to freehand and other drawing.

That, in pursuance of this opinion, your memorialists have already established a class for the study of vocal Music by notes, and have placed it under a competent instructor; but they consider it probable that comparatively little progress will be made until the cost of such classes is made merely nominal, and the interest of elementary teachers generally in this subject is secured by the granting of public money for scientific tuition in Music.

Signed on behalf of the School Board for the district of the city of Manchester.

(Signed) HERBERT BIRLEY, Chairman.
FRANK ORDE RUSPINI, Clerk.

The answers made to the foregoing memorials were merely formal acknowledgments.

It is hoped that these memorials from Manchester will be followed by similar ones in all parts of the country, and that a national movement will be made to organise instruction in Music as effectively as on the Continent.

THE MINT.

The Report of the Deputy-Master of the Mint, the Hon. C. W. Fremantle, for 1877, has just been printed. It is dated the 8th May last. As is usual, the first portion of the report is devoted to statistics. During the year 1877, coins of 15 denominations were struck. In gold, only half sovereigns were coined. In silver, besides the ordinary coins, fourpences, twopences, and pence were struck for "Maundy money." No farthings were struck. The Mint also produced silver pieces of 20, 10, and five cents for the Straits Settlements, and bronze cents for Hong-Kong. The total number of pieces struck during the year was 30,131,130, against 11,239,050 in 1876; and their value, real or nominal, was £1,567,936 15s. 6½d. The continued depression in trade has caused a moderate demand for coin generally, but the reason for no sovereigns having been coined is not this small demand but the large importation from Sydney and Melbourne. In the silver coinage the amount struck in 1877, however, greatly exceeded the amount in 1876, simply because, in the last-named year, the antiquated machinery of the Mint broke down, and for five months the coinage operations were entirely suspended. From this cause there was, in 1876, a deficiency of silver coin, which had to be made good in 1877, and an excess of nearly £100,000 in silver coin, is thus accounted for.

The average price paid for silver during the year was 4s. $8\frac{1}{10}$d. per ounce; the silver coin is issued to the public at a rate of 5s. 6d. per ounce, and thus the seignorage accruing to the State has been $9\frac{1}{16}$d. per ounce, or $17\frac{3}{4}$ per cent. In 1876, no silver was bought, but if any purchases had been made the seignorage would have been greater, as the price of silver was lower, 4s. 5d. per ounce. The seignorage during the past seven years has varied widely, the limits being 9 per cent. in 1870, and $17\frac{3}{4}$ in 1877, and has risen steadily year by year, no account being taken of the year 1876, in which no silver was bought.

The bronze coinage, like that of the more precious metals, was affected by the condition of trade. The amount was slightly below that of 1876, and considerably below that of the two years previous. It is a somewhat curious illustration of the conditions under which the Mint works, that from August to the end of the year no bronze coin were issued "owing to the accumulation of coin of those denominations in the hands of the London brewers, to whom, as on former occasions, applicants resident in the district were referred, instead of being supplied with new coin." In the same way during a part of the year, applicants for threepences were not supplied direct, but were referred to "a London bank known to have a surplus stock of these coins."

The end of 1877 was the date fixed for the final calling in of the old copper coinage from the colonies, where it was allowed to pass current after it had ceased to be a legal tender in England. The end of June, 1876, was first fixed as the date up to which the old coin was to be received at the Mint, but in 1873 it was found that the amounts coming into the Mint were insignificant, and, accordingly, it was determined that after the end of July in that year, the old copper coin should no longer be received at the Mint at its nominal value, and so far as the United Kingdom was concerned, it ceased to be a legal tender. In the case of the colonies, however, an extension of time was granted, and the date fixed at the end of 1877. Accordingly, at the expiration of last year, the old copper coinage ceased to be legal coin in any part of the empire.

What was the precise amount of copper coin in circulation when its withdrawal was determined on, it does not seem to have been possible to determine. It consisted of coins issued between 1797 and 1856, the coins of dates anterior to 1797 having disappeared from circulation, the process of disappearance being considerably aided by the fact that variations in the price of copper at times raised their intrinsic beyond their nominal value, and so made it profitable to melt them down and sell them as metal. The money withdrawn was £580,360, and it is believed that very little of this old money still remains in circulation, either at home or in the colonies, though probably a certain quantity yet exists in distant settlements. This leaves unaccounted for the large sum of £656,376, which represents the difference between the amount originally issued and that eventually withdrawn. The amount of bronze coin issued from 1860 to the end of 1877 was £1,367,963. "From these figures it would appear that the amount of bronze coin in circulation is considerably more than double that of the copper coinage which it replaced."

Besides the coins actually made at the Mint, Messrs. Heaton, of Birmingham, produced a new coinage of bronze pence, half-pence, and farthings for the State of Jersey; new "susidiary coinages" of ten and twenty cent pieces in silver, and five, two, and one cent pieces in bronze, for Mauritius, and a silver coinage of

the nominal value of 48,000 dollars in pieces of twenty, ten, and five cents for Hong Kong. The question of coining dollars for Hong Kong, which might supersede the Mexican dollar, has been for some time before the Mint authorities, but it has, up to the present, been decided in the negative.

The net profit on the year's work was £32,041, arising entirely out of the silver and bronze coinage. This revenue varies considerably. In 1876, owing to the five months stoppage, there was a deficit, in 1875 there was a profit of £75,802 as against £26,435 in 1874, and £40,564 in 1873.

The museum of the Mint, first opened to the public in 1873, has been enriched by the purchase of such portions of "treasure trove" as possessed numismatic interest. The practice with regard to "treasure trove" is that the specimens, after inspection at the British Museum, are sent to the Mint for a report on their metallic value. The coins selected for purchase consisted of 45 silver pence of William the Conqueror, found at Tamworth; three gold nobles of Edward III., Richard II., and Philip III., Duke of Burgundy, from Chalcot, in Wiltshire; and three gold crowns of Henry VIII., found at Bisham Abbey.

Steps have been taken during the year to commence a scientific library. The old library of the Mint—bequeathed, for the most part, by Sir Joseph Banks—is rich in books on numismatics and currency, but poor in scientific works. A number of such of these as are likely to be useful have now been procured, as well as certain of the chemical and physical journals, English, French, and German.

The number of visitors during the year was very large, 1,848 orders of admissions having been given, and 7,409 persons admitted. As is usual with the chemical department of the Mint, such time as could be spared from routine work has been devoted to scientific research. The experiments commenced in 1876, with the view of ascertaining whether a relation could be established between the composition of gold-copper alloys and their densities. These have been continued, and "the results show that it would be possible to arrange a method by which the composition of a mass of coins would be verified without destroying their integrity." The same investigations had borne useful results in the directions of showing the effect of compression and annealing on gold.

A new process for producing dies was brought under the notice of the Mint authorities, and both Mr. Fremantle and Mr. Chandler Roberts went to visit certain European mints where the process was being tested. It was a secret process, and the inventor asked a high price for it, nor is its adoption recommended. One objection is characteristic of the present state of our Mint. Whether or no the dies produced may serve in other mints it is considered uncertain if they would suit the ponderous machinery of our own.

Having concluded his history of the doings of the year in the English Mint, Mr. Fremantle gives the substance of the reports by the Deputy-Masters of the Sydney and Melbourne Mints. He then devotes a few pages of the report to some remarks on the general design of coins, setting forth "such facts in connexion with it as will serve to show the phases through which decorative art, as applied to coinage, has passed." This part of the report is illustrated by a sheet of coins reproduced by a photographic process, the last of which is the reverse of the modern shilling, introduced probably for the sake of contrast. It is remarked that coins have not always exactly reflected contemporary art, and the present state of our coinage is, therefore, attributed to the bad taste of a former generation rather than to that of our own days. Mr. Fremantle does not admit the necessity for placing on the coin any special statement of its value. He laments the taste, or absence of taste, which is satisfied with a wreath surrounding the words "One shilling," but thinks "this indifference to beauty of design is no sufficient reason for perpetuating so feeble a method of treatment."

The next part of the report treats of the coinage of foreign countries. A short sketch of the history of the United States coinage since 1792 is given. As regards Germany, the principal fact noted seems to be that no further steps have been taken to complete the demonetisation of silver. The countries forming the "Latin Union," France, Belgium, Italy, Switzerland, and Greece, have made no alteration in their arrangement—adopted since 1873—for limiting their coinage of silver. The Indian coinages have been unusually large. The coinage executed at the Japanese Mint was large, and pieces examined by the Mint in London showed that the work was done with very great accuracy. The total number of pieces struck was 114,536,000.

In conclusion, the question of a new Mint is discussed, and the objections to the proposed change are combated. It is stated that no refinery would be attached to the new Mint, the refinery adjoining the present Mint having actually been leased out since 1852. The operations of the Mint are perfectly innocuous, all the metals being refined; even in melting the bronze there are no noxious fumes. The number of artisans employed would not greatly exceed 50, all of a superior class. Finally, Mr. Fremantle refers to the situations of the mints of Paris, Madrid, Vienna, Berlin, and Brussels all in central positions, and some even in fashionable resorts.

THE POPULATION OF THE EARTH.

The fifth publication of Behm and Wagner's well-known "Bevolkerung der Erde," is just out, giving some elaborate statistics on this subject.

Since the last publication of these statistics the population of the earth shows a total increase of 15 millions, partly arising from natural growth and partly the outcome of new and more exact censuses. The total population is now set down at 1,439,145,300, divided among the Continents as follows:—Europe, 312,398,480; Asia, 831 millions; Africa, 205,219,500; Australia and Polynesia, 4,411,300; America, 88,116,000. The following table gives the latest results for the chief countries in the world:—

EUROPE.

Germany, 1875	42,727,360
Austria-Hungary, 1876	37,350,000
Liechtenstein, 1876	8,664
Switzerland, 1876	2,759,854
Netherlands, 1876	3,865,456
Luxembourg, 1875	205,158
European Russia, 1872	72,392,770
Finland, 1875	1,912,647
Sweden, 1876	4,429,713
Norway, 1875	1,807,555
Denmark, 1876	1,903,000
Belgium, 1876	5,336,185
France, 1876	36,905,788
Great Britain, 1878	34,242,966
Faroes, 1876	10,600
Iceland, 1876	71,300
Spain (without Canaries), 1871	16,526,511
Andorra	12,000
Gibraltar, 1873	25,143
Portugal (with Azores), 1875	4,319,284
Italy, 1876	27,769,475
European Turkey (before division)	9,573,000
Roumania, 1873	5,073,000
Servia, 1876	1,366,923
Montenegro	185,000
Greece, 1870	1,457,894
Malta, 1873	145,604

Asia.

Siberia, 1873	3,440,362
Russian Central Asia	4,505,876
Turcoman Region	175,000
Khiva	700,000
Bokhara	2,030,000
Karategin	100,000
Caucasia, 1876	5,391,744
Asiatic Turkey	17,880,000
Samos, 1877	35,878
Arabia (independent)	3,700,000
Aden, 1872	22,707
Persia	6,000,000
Afghanistan	4,000,000
Kafiristan	300,000
Beloochistan	350,000
China proper	405,000,000
Chinese borderlands, including Eastern Turkestan and Djuugaria	29,580,000
Hongkong, 1876	139,144
Macao, 1871	71,834
Japan ,1874	33,623,373
British India within British Burmah, 1872	188,421,264
Native States	48,110,200
Himalaya States	3,300,000
French Settlements, 1875	271,460
Portuguese do. do.	444,617
Ceylon, 1875	2,459,542
Laccadives and Maldives	156,800
British Burmah, 1871	2,747,148
Manipur	126,000
Burmah	4,000,000
Siam	5,750,000
Annam	21,000,000
French Cochin China, 1875	1,600,000
Cambodia	890,000
Malacca (independent)	290,000
Straits Settlements	308,097
East Indian Islands	34,051,900

Australia, &c.

New South Wales, 1876	630,843
Victoria, 1876	841,938
South Australia, 1876	229,630
Queensland, 1876	187,100
West Australia, 1876	27,321
Tasmania, 1876	105,484
New Zealand and Chatham, 1876	444,545
Rest of Polynesia	1,896,090

In 1877, Algeria had 2,867,626 inhabitants. The population of Egypt is now estimated at 17 millions, and the equatorial regions of Africa at 44 millions. Caffre-land north of the Transvaal is estimated at a million; Orange River Free State, 65,000; the Transvaal, 275,000; Natal (in 1875), 326,959 inhabitants; and Cape Colony, 1,148,462. In America the figures are but little changed from those of the previous issue of these statistics. Greenland (1876) is estimated to have a population of 10,000; Nicaragua (1877), 300,000; Brazil (1872), 11,108,291; Guiana (1875), 342,300; Ecuador (1875), 1,066,000; Peru (1876), three millions; Chili (1875), 2,333,568; Uruguay (1876), 445,000; Paraguay (1876), 293,844.

It is stated that establishments for refining the Kerosene oil, which has long been known to exist in Japan are springing up rapidly in Japan, and the manufacture is becoming an important industry.

The *Builder* says that Capt. Calver is preparing a rejoinder to Sir Joseph Bazalgette's reply to his October report upon sewage disposal. A little detention will occur in its appearance, as the writer is adding to certain observations upon the currents of the Thames.

CORRESPONDENCE.

NATIONAL WATER SUPPLY.

Referring to the communication of Mr. George Frederick Wills (p. 798 of the *Journal*), on the difficulty of enforcing a water supply upon rural districts, owing to the fact of most of the governing body being agriculturists, and their objection to having land rated for the direct benefit of owners and occupiers in the urban part of the district, permit me to point out that a complete remedy exists in Sections 271 and 272 of the Public Health Act, 1875. Mr. Wills says:—"The remedy seems to me to be the compulsory formation of a district or local board, which shall raise the requisite funds from the locality immediately benefitted, and not including farms, lands, or dwellings out of the reach of such water supply."

Well, what do Sections 271 and 272 provide? Section 271 gives the Local Government Board power by provisional order to declare any rural district, or any portion of a rural district, to be a Local Government district; and Section 272 gives the Local Government Board power on a petition of one-tenth of the ratepayers to define the boundaries of any proposed district within a district and to make such newly-defined small district a separate and independent Local Government district for carrying into effect all the purposes of the Public Health Act, 1875.

Surely, here is the exact remedy Mr. Wills asks for, but has overlooked.

Let it be remembered, however, that the Board in London will not originate this proceeding. The ratepayers desiring a water supply for the urban part of their district, must themselves (to the extent of at least one-tenth of their number) memorialise the Board, and support their memorial by proper evidence, and it will be done. "The gods help them that help themselves."

If the town Mr. Wills refers to be that in which he resides, there is a compact urban population of nearly 3,500 people, and there is a splendid spring of pure water three miles distant, which only needs to be piped down and distributed, at a cost of about 30s. per head. The well waters in the town are, as Mr Wills says, notoriously bad.

There is no doubt that the interest and sinking fund upon the outlay for a proper water supply would be met by the reveuue, and that, in fact, the undertaking would not cost the ratepayers one farthing.

George Wilson Stevenson, C.E., F.G.S.

4, Westminster-chambers, S.W., 20th July, 1878.

GENERAL NOTES.

Trade Marks for Cotton Goods.—It may be interesting to persons connected with the cotton trade to know that the labours of the Committee of Experts, appointed by the Commissioners of Patents to divide the cotton marks sent in for registration into the two classes of "private marks" and "common marks," are drawing to a conclusion, so far as regards the marks used in the cotton trade at the date of the passing of the Trade Marks Registration Act (13th August, 1875). The examination of the marks used for yarns and miscellaneous cotton goods was completed last August. Since that date the committee have been engaged with the marks used upon cotton piece goods, of which they have already dealt with upward of 39,000, and the examination of the remainder will shortly be concluded.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,341. Vol. XXVI.

FRIDAY, AUGUST 2, 1878.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

COLLEGE OF MUSIC.

The following letter has been received by the Secretary:—

Buckingham Palace, 29th July, 1878.

Sir,—I have the honour to inform you that at a meeting held in Marlborough-house, under the presidency of the Prince of Wales, it was resolved to make an effort to establish a College of Music on a wider and more permanent basis than the Royal Academy of Music or the National Training School for Music. Both of these bodies have already intimated their readiness to co-operate in founding a college having for its purpose the improvement of the science and art of music, and the provision of musical instruction of the highest class.

As the Society of Arts took much interest and an active part in establishing the National Training School for Music, the Chairman of the Council of the Society has been asked to join the Executive Committee of the proposed College, and I have been requested to invite the Society to take interest and to co-operate in the measures necessary for the attainment of the object.

Sir, I have the honour to be
Yours faithfully,
Chr. Schleswig-Holstein.

To P. Le Neve Foster, Esq., Society of Arts.

PARIS EXHIBITION.—ARTISAN REPORTERS.

A meeting of the Joint Committee of H.M. Commissioners for the Exhibition and the Society of Arts was held on the 26th July. Present—The Earl Spencer, K.G. (in the chair), Lord Alfred S. Churchill, the Right Hon. Lyon Playfair, C.B., M.P., Admiral Sir Erasmus Ommanney, C.B., F.R.S., Mr. W. H. Perkin, F.R.S., Mr. A. J. Mundella, M.P., Mr. Henry Doulton, and Lieut.-Col. Donnelly, R.E., with Mr. Le Neve Foster, Secretary.

The Committee received the following report:—

The Joint Committee, at their first meeting, directed their Secretary to address a communication to the mayors of sundry towns, drawing their attention to the object the Committee had in view, and seeking their co-operation, in conjunction with Chambers of Commerce, where such bodies existed. Accordingly, a letter was addressed to 54 towns, a list of which is annexed.

The Committee also appointed a Sub-Committee to communicate with a selected number of employers connected with the leading trades of the metropolis, with a view to obtaining their opinion as to the best means of selecting artisans for the visit.

The Sub-Committee were also directed to communicate with some of the artisan class, in various trades, with a view to obtaining their advice and assistance in making a suitable selection.

Accordingly a Conference with employers took place, when each representative present undertook to communicate with others in his own business and report to the Committee.

The artisans, after conferring with the Sub-Committee, undertook to meet and send in for consideration of the Committee a list of those whom they considered fitted for the work in view.

The Committee, through the agency of Mr. P. Cunliffe Owen, C.B., the Secretary of the Royal Commission, have secured for the artisans lodging accommodation and board in Paris on most reasonable terms, and they have besides, through the liberality of the South Eastern Railway, the London, Chatham, and Dover Railway, and the Northern Railway of France, obtained the privilege of reduced fares. The details of these arrangements are given in the printed paper appended. (These were given in last week's *Journal.*)

This paper also gives the terms on which it is proposed to assist each man with £8.

As regards funds, the amount which has been subscribed in aid of the movement is £635 15s. A detailed list is appended.

While, however, this sum would not be sufficient, taken alone, for sending over to Paris an adequate number of men, it will be borne in mind, as appears below, that localities, firms, and individuals, are prepared to send over men at their own expense. The Committee, under these circumstances, have arranged to extend to such persons the privilege of the facilities in the way of reduced fares, board, lodging, &c., on condition of being furnished with a report from parties taking advantage of them.

The towns which replied to the communication as desirous of joining in the movement are—Bristol, proposing to send 10 men at their own expense; Leicester, 5 ditto; Sheffield, about 20; Stoke, 2; Leeds, 10 or 12; Huddersfield, 2; Bradford has already sent 6, and is proposing to send others.

The employers having communicated with others in their respective business, report:—

That five building firms are willing to send at their own expense 5 workmen.

That Messrs. Clowes, printers, are sending one of their men at their expense.

That the furniture trades have nominated 3 men.

That the Coachmakers' Company are sending 5 men at the expense of their Master.

That Messrs. Thrupp send 9 men at their expense.

That Mr. G. N. Hooper is sending 24 of his men at his expense.

The artisans have sent in a list of about 30 names for consideration.

The Artisans' Institute has also sent in a list of 12 names.

Applications from about 60 artisans have also been received.

A selection from the above will have to be made at once, and in order to facilitate this, a confidential letter has been addressed to the employer of each man.

The first batch of men is arranged to start on the 1st of August, and consists of:—

3 Builders.
5 Coachmakers.
4 Cabinetmakers.
1 Glass worker.
2 Potters.
1 Engineer.

Also 33 coachmakers belonging to the firms of Messrs. Thrupp and Maberly, and Mr. G. N. Hooper.

List of Towns.

Aberdeen.	Kidderminster.
Banbury.	Leeds.
Barrow.	Leicester.
Bedford.	Lincoln.
Belfast.	Liverpool.
Birmingham.	Macclesfield.
Bradford.	Manchester.
Bristol.	Merthyr.
Cardiff.	Middlesborough.
Coventry.	Newcastle-on-Tyne.
Derby.	Northampton.
Dublin.	Norwich.
Dundee.	Nottingham.
Edinburgh.	Oldham.
Exeter.	Paisley.
Frome.	Rochdale.
Glasgow.	St. Helen's.
Grantham.	Sheffield.
Greenock.	Stoke.
Halifax.	Stroud.
Hanley.	Sunderland.
Hawick (N.B.).	Swansea.
Heckmondwick.	Truro.
Huddersfield.	Wakefield.
Hull.	Walsall.
Ipswich.	Wolverhampton.
Kendal.	Worcester.

List of Subscribers.

	£	s.
Her Majesty's Commissioners	105	0
The Society of Arts	105	0
His Royal Highness the Prince of Wales, President of the Royal Commission ..	50	0
The Worshipful Company of Fishmongers	26	5
The Worshipful Company of Carpenters	10	10
The Earl Spencer, K.G................	26	5
The Worshipful Company of Salters	10	10
The Worshipful Company of Clothworkers	100	0
The Worshipful Company of Drapers ..	52	10
The Worshipful Company of Mercers....	52	10
The Builders' Society	21	0
Mr. Samuel Morley, M.P...............	50	0
The Worshipful Company of Cordwainers	26	5
The Worshipful Company of Haberdashers	21	0
A. H. Brown, M.P. (Messrs. Craven Dunnill and Co.)	10	0
Messrs. Eyre and Spottiswoode	5	0
Messrs. Gillows and Co................	5	0
Mr. E. P. Bodley, Burslem	5	0

GROSVENOR HOUSE.

The Duke of Westminster is desirous that designers, artisans, and the like, employed in any branch of Art applied to productive industry, should have the opportunity of inspecting Grosvenor House, with its Works of Art, daily, including Sundays, during the months of August and September, 1878, from 2 p.m. to 6 p.m. He regrets that, for want of room, he cannot extend the admission beyond the persons specified.

A number of tickets of admission have been placed in the hands of the Secretary of the Society, for distribution among persons answering to the above description.

Such persons can obtain tickets on application at the Society's house, by bringing with them a paper containing their names, addresses, and occupations.

Each ticket admits a party of four.

There will be no admission on wet afternoons.

CANTOR LECTURES.

THE APPLICATION OF PHOTOGRAPHY TO THE PRODUCTION OF PRINTING SURFACES AND PICTURES IN PIGMENT.

By Thomas Bolas, Esq., F.C.S.

Lecture III.

Line Engraving on Metal Plates.

We now go back to the first photographic process discovered—that is to say, the first process which gave photographic representations which could be exposed to light without destruction—the bitumen process of the hard-working and patient Niépce. This investigator noticed that the residue left on the drying of certain varnishes became insoluble by exposure to light. About the year 1814, he covered metal plates with a bituminous varnish, exposed them in the camera obscura, and after exposure he subjected them to the action of similar solvents to those originally employed in making the varnish. Under these circumstances those parts of the film which had been exposed to strong light refused to dissolve, while the unexposed parts dissolved, a negative image being thus formed on the metal plate. To convert this negative image into a positive, those parts of the metal which were uncovered by bituminous matter were darkened by the vapour of iodine, and the bitumen was then removed by the use of a more powerful solvent. By the application of a suitable acid to the bitumen pictures on metal, the bare parts were dissolved away, and engraved plates were obtained. Here is a specimen of bitumen or mineral pitch—a substance which is found in most quarters of the world. Let us powder a little, and pour benzole on it; you see that it dissolves quite easily, and the solution runs freely through this paper filter. You see that the solution is about as thick as collodion, or perhaps, rather thinner. Now, here is a carefully cleaned copper plate, such as the engravers use, and you

see that I am going to clamp it down on to this turn-table. The next step is to flood the plate with bitumen solution, and then to make the table revolve quickly. Now it has revolved a few seconds, and I think the film will be dry. Here it is; I hand it round, so that you can judge for yourselves as to the advantages of this method of coating the plate. I know of no other method by which such a uniform and compact film of bitumen can be obtained. After coating, it is well to put the plate aside for twelve hours, in order that the film may become harder. It is then necessary to dust it over with French chalk, to remove stickiness; and, after this, it is placed behind a transparency, and exposed to light. The time of this exposure may vary from twenty minutes to two days.

Here is a plate which has had the requisite exposure, and the next matter is to dissolve away that portion of the bitumen which has not been made insoluble by the action of light. Now, benzole is too energetic a solvent for my purpose, and oil of turpentine is not sufficiently active; but, by mixing these together, you can get any degree of solvent power which you may require. I will get Mr. Barker to treat this plate with the solvents. You see that he commences by flooding the plate with oil of turpentine, and, as this has not sufficient action, he pours it off, and adds a little benzole; this begins to produce an effect, and enables him to judge as to the amount of benzole which he may safely add to the oil of turpentine. He has added this quantity, and has now washed away all the soluble bitumen from the plate, which is next thoroughly rinsed with water to remove the oil of turpentine. You see how extremely sharp and well-defined the lines are. I next place the plate in nitric acid, so as to etch the lines where the metal is bare; and while the etching is in progress, I will get Mr. Barker to dissolve away the soluble bitumen from this glass plate, when we shall find remaining the bituminous reproduction of a page of letterpress, which I can show you by means of the lantern. Our first plate is now sufficiently etched, and when I have cleared off all the bitumen, by rubbing with a rag and benzole, the plate will be ready for the printer. It is now clean, and I will hand it round for you to examine.

Mr. Barker has now the bitumen image on the glass plate, ready for the lantern; the image is now on the screen, and you see how sharp and well defined the lines are; I take the plate out, and if you examine it, you will notice that the letters are raised on the glass—they being, as you know, formed of insoluble bitumen. If we wish to etch the glass, it is merely necessary to expose it to the action of hydrofluoric acid, as I do now.

So much for the line-engraving process of Niépce; but before you go I want to show you that very perfect half-tone transparency pictures may be produced by means of bitumen. Here are some pieces of sheet gelatine, and some pieces of talc, which have been varnished on one side with bituminous varnish. I hold two of these, one being on talc and the other on gelatine, over against the lime-light, and you merely see even films of bitumen, but no image. There is, however, in each case a picture of insoluble bitumen imbedded in the films, and I will get Mr. Barker to dissolve away the soluble portions, so as to lay bare this hidden image. He will use a mixture of oil of turpentine and benzole as a solvent.

Supposing that the varnished side of the talc or gelatine is placed in contact with the negative, and the light is allowed to shine through it; those parts of the bitumen film which are under the perfectly transparent parts of the negative become insoluble, let us say, all through. Now, those parts of the film which are under less transparent parts of the negative, do not become insoluble all through, but a skin of insoluble bitumen is formed on the surface of the bitumen film, this skin varying in thickness according to the amount of light which has given rise to it. Put a varnished and exposed gelatine sheet of this kind into the solvents, and note the effect. When the film is made insoluble all through, it resists the action and remains on the talc; but where only a skin of insoluble bitumen exists on the surface of the film, the solvents loosen and dissolve the bitumen from underneath this skin, and away it floats. Now you can understand why the bitumen process, in its ordinary form, is only adapted for the reproduction of subjects in extreme black and white, such as line engravings or letterpress. Now, if we wish to preserve the half-tone picture intact, we must expose through the transparent medium (talc or gelatine) so as to ensure every part of the insoluble image, whatever its thickness, being in contact with the transparent support. Those prints which Mr. Barker is developing were done in this way, the talc or gelatine being placed in contact with the negative. The small thickness of talc or gelatine does not render the image notably unsharp. It was only during the last week that I thought of making bitumen transparencies by this method of printing against the back of the film, so I have not had time to make many examples. Mr. Barker has now finished the washing away of the soluble bitumen from those which he took in hand some minutes ago, and as I exhibit them on the screen, you will see how perfectly all the gradations of half-tone are represented. You quite understand that a picture of this kind is solid, the gradations of light and shade being due to a greater or less thickness of bitumen, and that the essential points in producing them are to varnish a thin, transparent medium with bitumen, to expose to light through this medium, and then to dissolve away that portion of the bitumen which has not been acted on by light. The ordinary black varnish sold for backing glass positives will answer very well, and so will some samples of Brunswick black. Here is a transparency which was made with ordinary Brunswick black; remember, however, that some samples of Brunswick black are not sensitive to light, these being probably made with coal pitch.

I think that by the method which I have just indicated, very fine lantern slides may be produced, as there is an entire absence of texture or granularity, and it is probable that the bitumen pictures may be stained or toned without difficulty. As I told you before, I only recently thought of this method, and perhaps some of you will experiment with it.

On the table are some plates and specimens illustrating the process of engraving on bitumenised plates, and you will specially notice the great clearness and sharpness of the lines produced by

this method. Messrs. Leitch and Co. have kindly lent me some of their photo-engraved plates, which you will examine with much interest. These copper plates have been covered with a thin film of iron, by the electrolytic method, and as the film of iron is extremely thin, it does not in any way interfere with the printing qualities of the plates. When the surface of a plate begins to wear a little, and the impressions show signs of deterioration, the plate is sent back to Messrs. Leitch and Co.'s factory, where the film of iron is dissolved off by means of dilute sulphuric acid, leaving the copper plate as good as ever. The film of iron, although so thin as not to injure the printing qualities of the plate, is nevertheless sufficiently thick to protect the copper from injury in printing. The plate having been freed from the first worn-out film of iron, is once more coated with a layer of iron, and is again ready for use. When the second film of iron is nearly worn away, and the printer approaches near to the true surface of the copper plate, the iron is again dissolved away, and a new coating of iron is put. According to this system, one really prints rather from a cast of the plate than from the original plate, and new casts are made as required.

Here are some admirable specimens of photographic engraving by Mr. Dallas, a gentleman who is always to the fore in matters connected with photo-mechanical printing.*

Before you go I wish to call your attention to a very simple and expeditious way of making engraved plates from line subjects. Here is a photo-lithographic transfer made from a positive, instead of from a negative, as is usually the case. You see that the ground is black, and the lines are white; in fact, by far the greater part of its surface is black. I now lay it on a zinc plate, and pass it through the press. Now, what will be the result? I will tell you beforehand. So much of the paper being covered with printing ink, and so little being white, moist, and gelatinous, the transfer will slide over the zinc plate, and we shall merely get a smear. Here it is. I have here another transfer similar to the last, excepting that white patches are introduced on it wherever they can be introduced without falling foul of the picture. This is done by painting on the transparency with Brunswick black. On putting this transfer down on a zinc plate you see that it adheres properly, and we have a perfect image on the metal. As the white patches are now done with, I varnish them over, and you see that the zinc is covered everywhere except where the lines of the engraving are bare. The covering on the zinc is now made denser by inking and dusting with resin, as I explained in the last lecture, and the plate is then etched by dilute nitric acid. Here is a plate all ready inked and dusted; I place it in this dish of nitric acid, and allow it to remain a few minutes. I now clean off the ink, and you see the lines are engraved on the zinc plate. The plate may now be printed from in the copper-plate press, or, as zinc is not a convenient metal for deep plate-printing, it may be reproduced by the electrotype process.

* After the lecture, Mr. Dallas informed me that he has been in the habit of coating the surface of his plates with iron, as described above.—T. B.

HEALTH AND SEWAGE OF TOWNS.

The following are some of the communications brought before the Conference, held on the 23rd and 24th May:—

WATER-CARRIED SEWAGE AND CEMENT MANUFACTURE.

By James Richards.

The directors of Scott's Sewage Company (Limited) have instructed me, as their secretary, to bring before the Conference on Health and Sewage the success which attended their operations in preventing the pollution of the Pendle water, a branch of the Calder River, and utilising the precipitated sludge, by making cements of various kinds, at their works, at Duckpits, Burnley, in Lancashire.

Members of the Society of Arts, engineers, sanitary authorities, and the public at large, are invited to inspect these works, two miles from Burnley, Lancashire, which show how the pollution of any river by sewage can be effectually prevented. A clear effluent is obtained possessing improved fertilising properties, if required for agricultural purposes, but which otherwise may be allowed, without detriment to water, to flow into any river, whilst at the same time, all the nuisance arising from the noxious sludge is avoided by its conversion into Portland and other hydraulic cements, which compete in quality and price with the best cements sold in the neighbourhood.

The Corporation of Burnley, some years ago, were prohibited by injunction from allowing the effluent from the sewers of the town to flow into and pollute the River Calder. The Corporation and Scott's Company entered into a contract, whereby Scott's Company engaged to produce, and have produced a clear effluent, the injunction has been put aside, and the effluent now passes into the river, and the Corporation has recorded its satisfaction at the results.

The works at Duckpits have been erected by the Corporation of Burnley, after the designs of Mr. W. B. Bryan, C.E., which exemplify the latest scientific views on the subject, in order to deal with all the sewage of the town and district except the floods of storm water, which pass through the sewers, and at times are great, caused by the heavy rains, which in 1876 varied from 38 inches to 44 inches at Burnley.

The Corporation deliver the sewage into the tanks, and then Scott's Company purifies it by lime precipitation and filtration through coke. The clear effluent passes into the Pendle water, which joins the River Calder.

The sludge, always an offensive difficulty, which has not hitherto been dealt with satisfactorily, is entirely cleared away by its conversion into cements, Portland, hydraulic, and Roman cements. All cement that has hitherto been made has been sold or used in the works.

Some doubts have been expressed, if in the wide extension of this system there will be a sufficient demand for the cements, but they may be answered by remembering that as long as buildings are wanted, and concrete walls are

cheaper and more durable than brickwork, the use of cement is practically unlimited.

The company is open to make contracts with any other sanitary authority, and give a guarantee of success. The nature of the contract and the cost of working the processes are determined by local circumstances. The total cost of the cement process gives satisfactory results in the effluent, and disposes of the sludge at a rate as cheap as the average cost of the several experimental processes stated in the Local Government report of 1876; and will not exceed 7d. in the pound yearly on the rateable value, unless the local circumstances are very unfavourable.

The following are the testimonials in favour of these processes, given by the highest engineering and chemical authorities, and they can no longer be disputed, Scott's Company having now proved their soundness:—

The Lime Process.

Dr. J. H. Gilbert, F.R.S., Royal Commissioner on the Sewage of Towns, says:—

"Of all the disinfecting methods which have yet been proposed, I believe that which is known as the lime process is by far the most practicable and effective on a large scale. The lime process does effectually remove this solid suspended matter, and in so far accomplishes a great and manifest good. It also destroys the influence of the noxious gases of sewage, and . . . . we are of opinion that wherever this (clarified) liquid (sewage) is thrown into a body of water considerably larger than itself, no evil results will practically be experienced."

The Cement Process—Economy.

Dr. Odling, F.R.S., says:—

1. "Economically, the scheme seems to me the most promising of all which has been introduced for the purpose of dealing with sewage, and throwing down the sludge from it, and then dealing with the solid portion, so as to convert it into a useful marketable article. I do not think there is any commercial value in the material that will be extracted at Dunton, unless they make it into cement."

No Nuisance.

Dr. Frankland, F.R.S., says:—

2. "I should prefer to treat it with lime alone, and to use the sludge according to General Scott's process, which does not occasion the slightest nuisance."

Fish can Live in Limed Water.

Professor Crookes and General Scott have both stated in the discussions at the Society of Arts, that fish would live in it.

Not Unhealthy.

Dr. Frankland, F.R.S., says:—

3. "That deposit would be first dried, and then burnt in kilns, and then transformed into Portland cement. That appears to me to be the process of dealing with this sludge, which has always been a difficulty. It appears to me that this is the process least open to objection. I think it is very perfect in preventing nuisance. I would just say to that portion of the meeting who are not chemists, as to the gases produced in burning the cement, that this process of burning the carbon of the organic matter in the original sewage converts it into carbonic acid gas, and the only thing that can do harm is carbonic acid gas which exists in the atmosphere, and is diffused so rapidly through the atmosphere that, at a distance of 100 yards from the kiln, it would be difficult to find more carbonic acid gas than is normally there."

"In a sanitary point of view, the careful precipitation of sewage with lime has undoubtedly been very successful."—Dr. Letheby.

4. Colonel Francis having remarked at a public meeting, in 1872, "That looking to the deleterious matters contained in the original sewage, he thought that making cement from these materials, buildings might be injurious to public health." Dr. Frankland replied: "There can be no possibility of injury; all chemists are agreed upon that."

Dr. Voelcker says:—

5. "I wish to bear testimony to the fact that the process of drying and manufacturing the dried material into cement could be carried on in the immediate neighbourhood of the town where the sewage was obtained, without creating the slightest nuisance."

Equal to Excellent Portland Cement.

Professor Abel, F.R.S., says:—

6. "I examined them (specimens of the deposits), not merely in regard to their power of being converted regularly into a species of cement, but also with regard to the quality of cement; and I found it was equal to excellent Portland cement."

7. Q. "I understand you to say that it (the sludge) was converted into something more solid than that?"—A. " . . . It can be converted, by General Scott's process, into a very useful and valuable cement." Q. "That cement is manufactured out of the sludge so deposited?"—A. "Yes; and a very excellent cement it is."—Evidence by Mr. J. Hawksley, then President of Institution of Civil Engineers.

8. Q. "Have you formed an opinion as to whether the process was a valuable one, and likely to come into general use?"—A. "I think it is; I have the very highest opinion of it."—Mr. Bramwell, C.E., F.R.S.

9. "General Scott's plan, as far as I am aware, is certainly the best, and I really hope that it will prove successful, and be adopted in many parts of the country."—Mr. R. Grantham, President of the Committee on Sewage of the British Association.

10. "His process is very simple; does not require any very great outlay; and, so far as it goes, is thoroughly successful. He professes to clarify the sewage; to deodorise the effluent water temporarily, and the sludge permanently; and he does it. He also professes to make a very good hydraulic cement, of any desired strength; and he does it."—Mr. W. Hope, V.C.

11. "He calculated, therefore, that two tons and a half of this cement would be obtained from a million gallons of sewage. That would be about a ton for every 10,000 people per day. Well, he did not know what might be the demand for cement, but it did not strike him, at first sight, as being a very large quantity. Such a quantity might very well be used in building operations."—Dr. Letheby.

SEWAGE PRECIPITATION.—A RECOMMENDATION.

By William White.

As to sewage purification, it has to be admitted that at present authority is wholly in favour of irrigation; and so much so, that other methods are regarded as unworthy of discussion. It is allowed that there may be circumstances in which irrigation is not conveniently practicable; but the concession is made so reluctantly as to beget the

suspicion that, if only the requisite pains were taken, the true panacea would be found available.

Such a condition of opinion is to be regretted for several reasons. It is certain that there are many towns so situated that irrigation is an impossible prescription, unless at ruinous expenditure; and there are other towns where the sewage is so contaminated with manufacturing refuse as would render it a source of blight instead of fertility.

Communities so circumstanced are therefore compelled to resort to precipitation; but, left without competent counsel and guidance, are apt to fall into the hands of adventurers whose promises are as liberal as they are fabulous. What do the run of town councillors know of the chemistry of sewage? And yet on such councillors is laid the burden of selecting the process whereby foul waters are to be turned into clean. Left to act according to such light as they can command, it is not surprising that they become responsible for many absurdities. One has not to go far to find sewage subjected to treatment which effects little improvement at considerable cost. There is a town in Staffordshire where, at this hour, sulphuric acid and lime are simultaneously run into the current of the sewage, and where mayor and aldermen go about proclaiming that nothing can be more successful than the system they have adopted.

Again, if one fact has been made clearer than another, it is that the sludge deposited from sewage is worth little or nothing to the farmer; and yet a town council recently entered into an onerous contract, on the faith of obtaining 26s. per ton for their raw sludge.

Again, there are many sewage works where sewage already alkaline is dosed with lime, and an effluent considerably more pernicious than the original sewage turned into the rivers. On some occasions remonstrance is met with the observation, that although the treatment may do little good, it is necessary to do something to satisfy the Local Government Board; and apparently the Board is easily satisfied.

Now, what I wish to maintain is, that it is a grave mistake for the Local Government Board thus to leave towns to their own devices in the matter of sewage precipitation. I have nothing to say against irrigation, the ideal method of sewage disposal; but that where irrigation is impracticable, the most efficient method of precipitation should be indicated or recommended. And to do so to good purpose, it would be advisable to issue a Commission to examine and report upon methods of precipitation. It is of great importance that the proper use of lime should be defined, so as to check its profuse and indiscriminate employment. Also to define the proper use of other popular precipitants, such as the sulphates of aluminum and iron, the chlorides of iron, aluminum and calcium, and the various solutions of the phosphates of calcium and aluminum. Along with the definition of the uses of these chemicals would go a classification of various classes of sewage, concentrated or dilute, domestic or manufacturing.

In short, without such information and guidance, it is matter of luck whether a public body that "goes in" for precipitation does not commit some incredible folly—incredible, I mean, to a chemist. The ignorance and assurance that stalk about delivering judgment on sewage purification have to be met to be appreciated, and it is high time that they be confronted with sound information.

VENTILATION OF SEWERS AND DRAINS.

By D. Ainley, M.R.C.S., L.R.C.P., &c., Officer of Health.

In the following remarks I wish to speak but briefly on the theory of sewer ventilation, and more fully on the practical results of the various systems in operation; for we have now-a-days quite a legion of fanciful and unworkable ideas which must early die, on account of their incompatibility with existing laws, habits, and conditions of the people.

Given a certain condition, viz., a network of sewers, and we have sewer gases. Their nature and formulæ are well known; but we are most concerned with their disease-producing power. That they are capable of generating disease which kills thousands, and prostrates tens of thousands annually, is generally admitted, hence the laudable ingenuity and activity in devising means to keep asunder sewer gases and human beings.

Such devices have been numerous. Among the first were "traps" of various kinds and names. and from our past experience, we can see that they have literally fulfilled their names; not only "traps," but "mantraps;" for thousands, trusting to their protection, have been deceived, and found them a delusion and a snare.

Then we had the introduction of upright pipes or shafts from the main sewers into the streets, and from w.c.'s up to the housetop; and then came the conflict of opinion as to the density and behaviour of sewer gases, whether they would go up these tubes, or whether they would not require some apparatus to draw them up, without which they would be of no use, and this matter was so unsettled, that each person was left to follow out his own notion as to what was best. Last year the great idea in advance may be expressed in one word, viz., "disconnection," and there can be no doubt of the value and importance which that word implies, and of the myriad dangers which its application would prevent; but, as supplementing or rendering unnecessary all the past schemes, we have what may be termed ventilation by exhaustion, and in a few words I will describe its principle and mechanism. The system is known as "Stott's system." It consists in connecting sewers and drains with the furnaces of steam boilers, or other furnaces with a strong draught. For this purpose the ashes place is enclosed by a door, so as to connect the pipe from the sewer or drain in any convenient manner. In all cases, however, it will be observed that the furnace to which a sewer or drain is connected for the purposes of ventilation, the connection must be so arranged that the furnace must only receive its supply of air to support combustion from such sewer or drain. Consequently, it must be continually exhausting the said sewers and drains of foul gases, which must also pass through the fire and be consumed, or rendered harmless.

After making a number of experiments on the

spot with the above system, Dr. Augus Smith wrote the following :—

"Some of the admired plans for ventilating sewers are positively dangerous, others are simply valueless. When the sewer air is brought through the fire, as by your method, it is impossible to imagine that it can escape purification to some extent, and one question of prominent importance is, to what extent?

"It is extremely probable that the destruction of all dangerous substances was complete in such cases as I saw. So far as we know, the substances to be destroyed are not very stable bodies, and are readily decomposed. We may say with safety that the method in question, viz., passing the sewer gases through the great fires of factories, will remove the most dangerous properties, and, if the speed of passage be not too great, the purification will be complete. If sulphuretted hydrogen be present it will burn, and the sulphurous acid formed will pass up with the same acid from the coals. If carbonic acid be in excess, it will pass up the chimney with the carbonic acid so constantly formed in the fire. If organic substances, either as germs or more developed living forms be present, they will not endure the heat unless driven through with great rapidity, and if the substances are in a state of putrefaction, that state will be destroyed by a similar heat. The result then is easily known, so far as theory goes; the process if performed well must render the purification complete. So far as practice is concerned, we may be sure that some and even the greater part in many cases of the noxious matters will be thoroughly rendered innocent, whether all or not is a question of size of furnace, amount of air passing, time of passage, and so on.

"The next point to be considered is—to what extent in the sewer is the current of air formed, or we may say, how far will one fire, burning a given amount of fuel, cause a draught in a sewer of a given size. It will require a good deal of experience to answer this question, and that experience can be obtained only by the use of the method in various situations; and I certainly feel justified in recommending that it should be tried and its action carefully examined. The distance to which the draught of air will extend in any sewer depends on the condition of the sewer as well as of the furnace, and I could not pretend to follow the matter into details without abundant experiment. I can say, however, that to cause the currents of air to pass from the interior of our houses into the sewer rather than in a contrary direction, would be to do an incalculable service to a great population, and, indeed, I doubt if there be any one sanitary problem of equal importance before us. It is sufficiently evident that your method solves it to some extent, and I believe it to be equally clear that it is the duty of those, who have the means in their power, to find to what extent the matter is applicable. If the range of action in the sewers be great, the public benefit will be great also. I hope the inquiry will be rigorously made."

The question then is, to what extent will the furnace exhaust the sewer, for it may be admitted that when once the gases and organic bodies are through the fires very little harm can they do.

The first experiment was made at West Vale, near Halifax; the amount of air passing through the fire was measured by the anemometer, and was 980 cubic feet per minute. The question then was, where does this air come from, or how far? The nearest opening was 7 yards from the furnace, and the furthest 300 yards away, and between the two points, 15 other openings or open gullies. Down each of these gullies the anemometer did not register more than about 20 cubic feet, but the fact was abundantly established that, in all of them, remote as well as near, there was a down current. The whole of these gullies were then made up, not absolutely, but in a rough and ready fashion, and the anemometer placed at the extremity of the sewer, when it indicated 490 cubic feet per minute, thus showing that, with well trapped gullies, the effect must extend over a very considerable area.

The next application of the system was to the Halifax Union Poorhouse, where some 400 inmates are constantly housed. The guardians in their report say that, since the adoption of Mr. Stott's system in the house, the bad smells, which have taken tons of chloride of lime to disinfect, have been entirely removed; that, although upwards of 150 cases of small-pox and fever have been brought into the infirmaries in a few months, with only four deaths, not one case has occurred among the inmates of any infectious disease; such immunity was never known before the sewers and drains were connected with the boilers.

The Corporation of Halifax then took it up, to see whether such connection with the boilers of mills would remove the complaints of bad smells from certain neighbourhoods. The first complaint came from one of the best parts of the town; it was loud and strong, the stench rising into some of the houses at certain times was unbearable; upon investigation, the cause was clearly discovered, viz., the passage into the sewers from several factories where wool was washed of the residual liquor after the soap had been extracted by the addition of sulphuric acid. This liquor, I need not say, was peculiarly offensive. The question then was, shall we stop the business in which this was made, or shall we find a remedy? As our wish was always to interfere as little as possible with business, we decided to connect the sewers with the furnaces of two of the factories; the result has been that we have not had a single complaint since. I ought to add that, several of the complaining houses were half a mile from the factories.

Shortly afterwards, in nearly the centre of the town, a similar complaint was made; it was only at certain well-defined times of the day that the stench was so very offensive, and we ascertained that these were the times when the liquid was run into the sewers out of the large cisterns in which it had been stored, so we tried the experiment of running off the liquid at midnight, thinking, of course, to cheat the people, but the effect was that some scores of people had to turn out of bed and out of doors too, to escape the noxious effluvia. We then connected the sewer with the boiler of the factory, continuing to use the drains as before, without a single complaint. This extends over a period of four years. A number of similar cases could be added, but the story is the same, viz., complaints which have found their remedy, thorough, effectual and simple, in the connection, on Stott's principle, of the sewers with the furnace of some factory or other furnace having a strong draught.

In 1873, the furnace of Castle Mills, Oldham, was connected with the sewers on Stott's principle, and after giving general satisfaction over a lengthened period, on the recommendation of Dr. Sutton, the Medical Officer of Health, the Corporation decided to have six other connections made in the most

complaining parts of the town, and the following were made in 1876:—

	Area of connecting pipes.	No. of revolutions of the anemomter.	Cubic feet of air passing per minute
	in in.		
Albion Mills ..	22 × 7½	6½	750
Horsedge Mills ..	23 × 7	13	1,520
Britannia Mills ..	21 × 6	10½	920
Providence Mills ..	22 × 8	6½	800
Hope Mills ..	20 × 8	10	1,090
Castle Mills ..	15 × 15	4½	700
			5,780

Thus we have for the six mills 5,780 cubic feet of air drawn through the sewers per minute; or for a day of 10½ hours, 3,641,400 cubic feet. When these had been in operation 12 months, Dr. Sutton gave a report to his committee, in which he says:—

"All are working well except one, the fireman stating that when the apparatus is closed, there is not sufficient draught for the fire, consequently the doors have to be opened. If it had been connected with Gravel-walks drain, as I recommended, instead of the Cross-street drain, it would have worked well, the drain in Gravel-walks being much larger. Several of the householders in the neighbourhood complain that the offensive smells from the street grids are as bad now as they were 12 months ago. (Query—Because the apparatus is not working). The inhabitants who resided some time previous to the adoption of this system in the other parts, informed Inspector Walton and myself that the offensive smells were considerably lessened, a result which they principally attributed to Stott's patent; but as Mr. Rawlinson, the Consulting Engineer to the Local Government Board, and who visited Oldham previous to my appointment, urged upon the Council the importance of removing the grid traps throughout the town for the purpose of promoting free ventilation, and which was carried out, a great portion of the efficacy of Stott's system is counteracted; but even under these circumstances a considerable amount of foul air is conducted from the tributary drains to the furnaces, where the sulphuretted hydrogen, ammonia, and organic compounds pass through the fire, and are rendered innocuous."

In the first week of this month (May) Dr. Sutton made a further inspection of the district partially under Stott's system, and the following is his report:—

Officer of Health's Department,
Town-hall, Oldham May 3rd, 1878.

Upon inspection, during this week, I find in every case where the same tenants now reside, who did so in September, 1877, that they, one and all, highly appreciate the great improvements of the atmosphere of their houses. Frequent complaints were formerly made to me of their rejecting their food, caused by the fœtid steam being blown into the streets through the grids, and into their houses through the slopstone pipes; and the mortality by simple continued fever and convulsions is materially reduced. I entertain the same opinion which I have always held that, in closely-confined and densely-populated districts, nothing surpasses this method of dealing with sewer gas.

J. M. Sutton, M.D.

Two years ago the managers of Smedley's establishment, at Matlock, not satisfied with the sanitary condition of the place, applied to Mr. Stott with regard to his invention, with the view of rendering the place as healthy as it was possible to make it. Mr. Stott examined the drainage, and suggested that the whole of the drains should be connected together, and then attached to the boiler on his principle. This was done in a most satisfactory manner, and the result has been all that could be desired. The large diagram shows the drains, and their mode of connection.

In conclusion, it will not be out of place to state that this principle is well adapted for the ventilation of steamships, by making the heat of the funnel the exhauster of the foul air below; nothing can possibly be simpler, more effectual, or more economical.

And just as I finish this paper comes the sad news of the explosion on board the mail steamer *Sardinian*, the facts of which are all well known to you; suffice it to say, that if this principle had been carried out on that steamer, such a catastrophe would have been an absolute impossibility.

FIVE YEARS' EXPERIENCE OF THE COCKERMOUTH METHOD OF DEALING WITH EXCRETA; AND A SUGGESTED ENLARGEMENT OF THE 40th SECTION OF THE PUBLIC HEALTH ACT OF 1875.

By John Makinson Fox.

Medical Officer of Health, Mid-Cheshire.

Wherever the human race is or has been found, there the excremental function is, and has been, performed. This is true of every age, of every place, of every dynasty, and of every religion and varying degree of civilisation. And its perpetual recurrence, and its intimate connection with the health and comfort of individuals, families, and communities, renders it everywhere and always equally obtrusive.

And yet, in the year 1874 of the Christian era, the report of the public health department of a nation that assumes a priority in civilisation, intelligence, and religion, says, at the conclusion of a searching and authorised investigation, "Nothing in the course of the present inquiry has given an inkling of support to a rather prevalent notion that some perfect scheme of excrement disposal, applicable to all sorts of places irrespectively, may be looked for, and action properly deferred until such scheme be forthcoming."*

Of so little practical economic value, in a matter the most elementary, affecting universally, both as to time and space, life and health, are the combined influences of history, science, and civilisation!

Whatever difference of view there may be as to the supernatural element in the book which is said to be the "foundation of England's greatness," it is admitted on all hands that Moses was a law-giver who has been unsurpassed; and the still surviving race for which he legislated are, and have been, through the procession of ages, monuments of his social wisdom.

It has been the practice of Western teachers of law and religion to concern themselves about things more glorious than the safe arrangement of the excremental process. The word "typhoid," in its definition and history, now so well and generally understood, has been the talisman that has

* Report of the Medical Officer to the Privy Council and Local Government Board, New Series, No. 1, page 141.

awakened statesmen and philanthropists to a knowledge of their error. Preventible diseases are now honoured by being recognised as national adversaries; and it is at last beginning to be considered to be as glorious to save lives at home as it has always been to save them on the field of battle.

Yet Moses gave to his people, and through them to the world and to all subsequent time, the leading principles which safely control the discharge of this essential and unavoidable function.* The principles are, instantaneous removal, combined with instantaneous disinfection.

I would blend the principles into one still more general and elementary, a violation of which, by anyone and anywhere, inevitably involves us in peril and in nuisance; a violation of which, therefore, should be defined, and dealt with always as a statutable offence.

The elementary principle I would enunciate is, that excrement once voided should be instaneously dealt with. To leave it to pollute the common air is a crime against the State and a sin against nature. Such a course indicates a criminal inconsiderateness in the offender, and is an undefinable but not less certain source of injury to others.

In the system of water-carriage, excrement is instantaneously dealt with by means of removal. In the tub or pail or pit, it should be as promptly dealt with by the absorbent ashes, or the more disinfecting dry earth.

In the latter system—I mean the dry system—automatic contrivances are not essential. Trouble must be incurred in some part of the process; and dirty and inconsiderate people will foul and spoil the best arrangements. Such persons must undergo a course of correction and education.

My assertion, therefore, is this: that excrement deposited and undealt with is always and everywhere an injurious nuisance, and should be dealt with accordingly. It matters not whether it be a single deposit in a street, or a pot retained in a dwelling, or a pit or a pailful in a curtilage, it must compulsorily be dealt with by removal, as by water; or be disinfected by earth or ashes, as in the dry system.

Whilst we are in agreement with the Inspectors of the Local Government Board, from whose report I have quoted, that no perfect dry system has been yet devised as universally applicable, we are, therefore, bound, I think, to proceed tentatively and inexpensively in any changes which we may oblige people to make with our present knowledge. But something is gained by having a fixed principle clearly defined, and by making all our changes, costly or otherwise, in accordance therewith.

It may be thought how destitute the rural district of the Cockermouth Union was of sanitary conveniences, when I say that 581 new privies have been built, under the direction of the authority, in five years, in a population of about 25,000 persons.

They have been erected after the simplest model, fitted with pails; and the only requisition in regard to them was, that a specially devised or other sifter should be used, by means of which the ashes from the hearth should be daily sifted upon the night-soil.

* Deut. xxiii., v. 12, 13, 14.

The result of the requisition is obviously to give complete simplicity to the action of householders, and to the report of Inspectors. In the present state of the law, it is a matter of undefined opinion whether a privy is a nuisance or not, and thus amenable to the correction of the law. But under the Cockermouth system, the report of the Inspector refers only to the fact whether or not the excreta are exposed, or the ashes in their proper place, namely, upon the excreta. The same simplicity is afforded in the directions given to house occupiers.

I can only testify that working people in that district are now ashamed when any offence of the kind I have mentioned can be charged against them; and to the action of so simple a requisition, gradually enforced through a period of five years, I ascribe in great measure the fact that in the year 1877 not a single adult, male or female, in the entire sanitary district, died from any of the list of zymotic complaints, which had been very fatal in the district in former years.

The addition to the 40th section of the Act, which I would suggest would be a definition that a privy was a nuisance, and to be reported and dealt with as such, when the excrement was not removed or covered in the manner indicated in the paper.

ON THE TREATMENT OF TOWN SEWAGE WITH REFERENCE TO THE HEALTH OF THE POPULATION, AND ESPECIALLY OF THAT PORTION OF THE SEWAGE WHICH IS KNOWN AS "HUMAN EXCRETA."

By Edwin Chesshire.

The paper which I shall have the honour of reading to you, at the solicitation of the Council of this Society, and at the recommendation of the Local Government Board, will be on the treatment of "town sewage" with reference to the health of the population. I shall, however, especially allude to that portion of the "sewage" which is known as "human excreta." *En passant*, I should wish to say, when I use the term "sewage," I shall mean the contents of the sewers, of whatever materials those contents may be composed; when I use the term "excreta," I shall mean the excreta of the population. It has been customary, even among scientific men—why, it is impossible to define—to speak of human excreta as "sewage;" and we frequently hear of the sewage of so many persons. Such a term is evidently a misnomer, as human beings certainly do not void sewage; such a term, too, is calculated to mislead us in the discussion and solution of the "sewage problem," a problem which is always difficult and intricate enough; still, great and intricate as that difficulty is, it has been created within the past half-century by the introduction of the underground water-closet cesspool system, and by the very men who are now seeking its removal—I mean the corporate bodies and local boards. I shall begin where every one should begin who desires thoroughly to ventilate his subject, where the difficulty starts from, and where its evils are most severely felt—I mean at the beginning—and I shall proceed to discuss the question as it affects the sanitary condition of the urban population. The insanitary evils which have occurred to the health of the

population by the introduction of underground or subterranean drainage are incalculable, and call for a prompt and effective remedy; those evils, however, would never have arisen, even from underground drainage, had the drains been used for their legitimate and proper purposes—I mean for the conveyance of liquids only. When an architect designs the plan of a house, he takes the greatest care, by means of traps and gratings, to prevent any solid matter entering the drains; but when he attempts to deal with the water-closet soil, strange as it may appear, he allows all the fæcal matter, viscid and tenacious as that substance is, all the paper, hair, dish-cloths, and other solid matters which are put down water-closets, to pass through the closet soil-pipe into the same system of drains, in the hope that the rainfall will come to his assistance and remove them. As far as he is able, he takes care, by connecting the roof water with the drains through the spouts, and the surface water through the gratings, to remove by water pressure this filthy mass from the house-drains. But, unfortunately for him, as it always has been and ever will be for sewage utilisers of the modern school, the rainfall is very capricious and irregular: it may not put in an appearance for a fortnight, or even for a month, during which time the collection of fæcal matter in the house drains is enormous. In this great metropolis I estimate, during dry weather, in one week, that about 1,200 tons of fæcal matter are collected in the house drains, or about one ounce and a half per head of the population per day. In those drains this collection of filth undergoes putrefaction and decomposition, generating sulphuretted and phosphoretted hydrogen and other foul gases, known as sewer or sewage gases; and it is those gases which so freely and so continually escape into the interior of houses through the various water-closets, sinks, lavatories, and waste-pipes. My late distinguished friend, Dr. Edmund Parkes, took great interest in my views on sewage disposal and utilisation; and I have a very lively recollection of the many agreeable visits with which he favoured me at my rooms in Birmingham. In reference to my plan, page 328, in his great work on "Practical Hygiene," after describing the construction of my sanitary interceptor, Dr. Parkes says the box is hermetically sealed, and trapped above and below; the result of this, he says, is that the urine runs off through the discharge-pipe, leaving the solid in the box; from time to time the solid is removed and the box cleaned out. Dr. Parkes says decomposition of the solid soil is certainly greatly delayed if not altogether arrested in this way. Many instances have been recorded, such as the propagation of Asiatic cholera by the celebrated Broad-street pump, an epidemic in Scotland, and the sudden and severe outbreak of typhoid in barracks at Munich, where the drinking water, polluted by percolation from sewers, drains, and middens, was made the medium by which the fever was propagated. Dr. Parkes says this medium of propagation has been admitted by men who have paid special attention to this subject, as Jenner, Budd, and Simon. Again, says Dr. Parkes, speaking of sewer gas, the diseases produced by fæcal emanations in the general population, seem to be diarrhœa, bilious disorders, often with febrile symptoms, dyspepsia, general malaise, anæmia. Typhoid fever is also intimately connected with sewage emanations, and, in addition, he says sewage air aggravates most decidedly the severity of all the exanthemata, erysipelas, hospital gangrene, and puerperal fever, and probably it has an injurious effect in all other cases. So long as the solid portion of the excreta from water-closets is cast into the drains—unless an arrangement can be made with the heavens to give us a continuous, or, at all events, a constantly repeated rainfall, so that the house-drains may always be effectually flushed—so long will those insanitary evils continue; but if the solid portion of the excreta were intercepted and retained in sealed iron boxes — sanitary interceptors — as I have suggested, the drains and sewers, as well as the rivers into which the sewage flows, would be relieved from pollution to a remarkable extent, the foul gases would no longer be generated, and the solid portion of the excreta would be put into a concentrated and portable form for utilisation, while the urine and other liquids would flow freely and continually away, to be dealt with at the sewer's outfall by subsidence and filtration, and ultimately, when clarified, to be applied to the land by intermittent downward filtration and irrigation, as I have so strongly and so frequently recommended. If we could imagine a section horizontally made under London, such section to pass through the house-drains, and if it were possible to lift up the upper portion of the section, we should witness a most revolting sight, and the residents of this great city would at once be made acquainted with the melancholy fact that they were living over, and almost in the midst of, a vast series or network of cesspools of the vilest description, more vile and more insanitary even than the old middens; bad as those middens were, those nasty receptacles were placed outside the houses, whereas the underground, elongated cesspools of the modern kind are almost in direct communication with the interior of dwelling-houses. It is not in the main sewers where the insanitary evils exist, for when the solid portion of the excreta of the population gets into those channels, provided they are sufficiently capacious, and are constructed with a sufficient fall, that material under the influence of the rainfall escapes quickly into the rivers, either through the storm outlets or the sewers' outfalls, where it pollutes and contaminates the rivers. Sometimes, however, cases occur, as recently happened at Brixton, where the main sewers were incapable of taking the soupy or slushy sewage which had to pass through them, by which regurgitation of filth into the streets and houses took place; but had the solid portion of the excreta of the population, and as far as practicable other solids also, been intercepted at the fountain-head, or at the starting-point in sanitary interceptors, the only point where interception is possible, the same main sewer which now refuses to permit the passage of the sewage, composed as it is of so much solid matter, would admit of its free escape, if liquids only formed the sewage; moreover, if liquids only were allowed to escape into the drain, such liquids would continually flow away, and no clogging of the drains would take place, and as there would then be no decomposition, no

foul gas would be generated. Johnson tells us, that a sewer is a passage for fluid, which is an excellent definition of the word. In consequence of the inhalations of sewer gas by the residents, blood-poisoning is constantly going on amongst the urban population, by which the vital powers are depressed and rendered unfit to cope with disease; hence it is that in an acute inflammation of any of the vital organs the tendency is to collapse—a circumstance which makes medical practitioners alive to the necessity of an early administration of stimulants to sustain life, and though such cases may not be true typhoid, the symptoms which cause death are very analogous to that disease. Many are the deaths now recorded as pneumonia, bronchitis, &c., which should be entered as typhoid; but the death-rate practically is no criterion of the healthiness of a city; the first thing to be ascertained before a satisfactory opinion can be formed as to the salubrity of any particular locality, is the relative proportion of children in the population. In this city, for instance, during the last five-and-thirty years, thousands of residents have removed into suburban districts, and have placed an elderly couple without a family either at the bank, the office, the shop, or the warehouse, as care-takers, while they have taken their children from London, where the death-rate should have been decreased, into the country, where the death-rate should have been proportionately increased, in consequence of the addition to the number of children in proportion to the adult population. At the Social Science meeting at Edinburgh, Dr. Christison, the president of the "Health" Section, told his hearers that there was a new disease in that city, a disease, said he, which is called typhoid or gastric fever; but, strange to say, it does not attack the houses of the poor where the ventilation is bad and the drainage imperfect; "but," said Dr. Christison, "it effects the houses of the rich, where the drainage is good and the ventilation excellent;" in truth, it affected those houses, and those houses alone, which were connected with the sewers, "the houses of the rich." In the report of Mr. J. N. Radcliffe to the Privy Council, it is stated that excrement-sodden earth, excrement-polluted air, and excrement-polluted water, are the principal factors in the product of diarrhœa and gastric fever, and that the condition chiefly productive of these diseases exists in its most dangerous form in improperly constructed and arranged, and imperfectly acting or stagnant sewers containing excrement.

Other instances equally strong have been reported, such as the epidemic of typhoid fever in the Cloisters of Westminster, where, says Mr. Simon, in those houses which were in communication with the sewers, the fever prevailed, whilst, in not one of those which were unconnected with the sewers, though in other respects their construction was inferior, did a single case occur. In Birmingham, where I am thoroughly familiar with the condition of things, when the Sewage Committee was appointed, that committee sought and obtained the advice of my own profession, and in every instance, I believe, on sanitary grounds, the members of that profession said "don't put the excreta into the sewers;" the committee itself, too, throughout the whole of its report, expressed the same views very strongly, yet, strange as it may appear, this committee has continued ever since to permit and even to encourage the escape of the water-closet soil through the drains and sewers; the consequence is, they (the committee) have utterly failed either in improving the sanitary condition of the borough (the average duration of human life in that town during the last two years being under 22 years), nor have they succeeded in utilising the excreta of the population, nor in freeing the River Tame from pollution in the smallest degree, a nuisance of which Lord Norton has so often and so justly complained. I am myself an unfortunate resident on the banks of the same river, lower down the polluted stream than Hams Hall, the seat of the noble lord; still, I have to complain very much of the foul emanations from the river. Prior to 1827, I believe it was, typhoid fever was an unknown disease in this country; Asiatic cholera and diphtheria are later importations; but those diseases, as well as diarrhœa and other affections of the alimentary canal, as I have before stated, are mainly, if not entirely, propagated through the medium of the bowel secretions, either in the atmosphere we breathe, or in the water we drink. The condition of the drainage of Marlborough-house, of the War-office, and even of the Local Government-office, is most unsatisfactory; in the latter building, though the drains are of modern construction and of the most costly description, the *Lancet* has devoted several articles to the consideration of the insanitary condition of that place, in consequence of the state of the drains. We have had many instances of typhoid attacks amongst illustrious persons owing to this cause, some of them, unfortunately, fatal. Dr. Edward Smith, medical officer of the Poor-law Board, in his "Handbook for Inspectors of Nuisances," page 162, says, "Mr. Chesshire, of Birmingham, has devised an ingenious arrangement by which the urine is separated from the fæces, and the solid part allowed to remain and accumulate until the box is full. It is so constructed that it may be applied either to a common privy in lieu of an aspect, or to a water-closet at some point intermediate between the seat and the sewer, catching the excreta of the household and retaining the solid or valuable portion in a portable form, while the liquid passes away into the sewer, and the drains remain perfectly clean."

Soon after the adoption of the water-closet system in its entirety in this metropolis—the Act was obtained, I believe, in 1844—the River Thames became polluted, the fish were destroyed, and the river itself was converted into an open sewer; and although the new drainage scheme, which has cost so many millions, has transferred the sewage from a point above to a point below London-bridge, it has left the metropolis itself riddled as it were by a vast series or network of underground elongated cesspools from end to end.

DISCHARGE OF SEWAGE INTO THE SEA.

By Henry Robinson, C.E.

A very general impression prevails that if a town is situated close to the sea it is necessarily in a more advantageous position than inland towns, respecting

the disposal of its sewage, as it has only to avail itself of its proximity to the sea to get rid of its sewage by discharging into it. That this is an erroneous impression the experience of most of our watering places proves, and it is therefore desirable to offer a caution to those who are contemplating adopting a similar course. In the Local Government Board Blue-book of 1876, one of the conclusions arrived at is as follows:—"That towns, situate on the sea-coast, or on tidal estuaries, may be allowed to turn sewage into the sea or estuary, below the line of low water, provided no nuisance is caused; and that such mode of getting rid of sewage may be allowed and justified on the score of economy." This has been often quoted as encouraging the adoption of this method of sewage disposal, and it is to be regretted that the report gives no data whatever (such as are abundantly available) by which the qualifying expression, "provided no nuisance is caused," would be shown to apply to a great number, if not the majority of cases. It might have been stated that, to avoid a nuisance, the sewage must be discharged into the sea at a point not only below low water, but where there is a well-ascertained current which would carry it permanently seaward. A point of discharge complying with these conditions is but seldom found to exist close to the town, but has to be reached by long and costly outfall sewers, or rather tunnels. At the outfalls there should be a continuous movement seaward during the 24 hours, instead of an oscillating action to and fro, resulting in a return of the sewage and its deposition along the shore, not only at the outfall and in its immediate neighbourhood, but also at distant places to which the tide carries. The writer has had occasion to inspect many watering places where the foreshore is being distinctly polluted in this way. At first the mischief is not great, and only traces of the sewage are visible; but in time it becomes serious, and the knowledge of the existence of sewage pollution on the foreshore causes the place to be avoided by those who hitherto have resorted to it. The grievance is not a merely sentimental one, as the exhalations along the foreshore from sewage accretions at low tide involve not only offensive smells, but also a danger to health.

The difficulties attending the discharge of sewage into the sea would be diminished were it not that it has a higher temperature and a lower specific gravity than sea or river water, which causes it to rise to the surface; and if it is not carried seaward at once, part of the suspended solid impurities are deposited on the coast wherever there is still water and no tidal current, whilst the rest of the suspended, together with the dissolved, impurities float on the surface, and are carried backwards and forwards by every tide, decomposing and liberating gases (sulphuretted hydrogen being one of the most offensive) injurious to health and polluting the air.

In some cases, by means of long outfall sewers, the sewage is carried clear away from the place producing it, as at Brighton. These practically become elongated cesspools, in which noxious gases are generated, and are liable to be forced back into the town drains, and thence into the houses. In these long outfalls, also, the solids deposit and involve both expense and difficulty to remove. Even if the places producing the sewage really get rid of it in this way, they are frequently simply transferring it to others, a set of the tide carrying it so as to cause mischief and nuisance elsewhere. No better illustration of this can be given than the experience of Margate. The authorities there proposed, after much competition amongst rival engineers, to adopt a scheme by which the sewage was to be discharged into the sea in a bay about a mile and a half eastward of the town, where it turned out that there was practically no current seaward, so that, had the scheme been carried out, the coast there would have been permanently polluted, as the sewage would have risen and dropped with the tide, evolving all kinds of dangerous and offensive gases, which would have effectually driven visitors away, and have depreciated to a serious extent the value of the neighbouring property. Ramsgate is in a similar difficulty, and many other places could be cited where it is a matter of serious concern how to deal with the sewage. The authorities are compelled to drain their towns, and the very effort they make to comply with the sanitary requirements of the day appears to involve them in almost greater difficulties. There is only one way safely of dealing with sewage at seaside places where the tidal currents are not clearly favourable, and that is, to deodorise the sewage before it is discharged into the sea.

The authorities of Glasgow have had the question of how to get rid of their sewage under consideration for a long while. A Royal Commission investigated this case, and although the result of this was to advise the adoption of a scheme to carry the sewage twenty-seven miles in a tunnel to the sea, at enormous cost, and although this advice was similar to that previously given, the authorities took the matter into their own hands, and appointed a committee of their body, which has recently presented an exceedingly able and interesting report, giving the results of their investigations. The conclusion they arrive at is not to adopt the recommendations to discharge their sewage into the sea, but to discharge it into the River Clyde after it has been purified by chemical treatment.

Where there is a risk of nuisance, either to the place to be drained or to its neighbours (which is equally important), by discharging sewage into the sea, a clarification and deodorisation of the sewage can be easily and cheaply effected. No attempt to arrest the solids in catchment tanks can possibly be satisfactory, inasmuch as they only remove a very small portion of the solids, and become huge cesspools, which have to be cleared out at intervals, with a certainty of causing great nuisance. Filtration is also not admissible, as the filters soon get inoperative, and become in addition as great a nuisance as catchment tanks. By deodorising the sewage the first difficulty is overcome, as the sewage is no longer offensive.

There has hitherto been much prejudice against chemical treatment, which is, however, disappearing, as it has been abundantly proved that sewage can thereby be deprived of its offensive properties by simple and inexpensive means. The disposal of the semi-fluid sludge has been a difficulty which the writer has had to give much attention to, and he has employed several methods

of converting it into a portable form. The plan which he has found the best is to remove a great part of the moisture from the sludge by means of a simple filter press. A model of this press (which is an automatic modification of an old construction of press) has been placed in the Exhibition of Sanitary Appliances. By an appliance of this kind, the sludge has the bulk of its water pressed out, and the consequent reduction both in mass and consistency enables the sludge to be better removed and utilised, or dealt with in any other way.

MISCELLANEOUS.

A NEW FORM OF TELEPHONE CALL.

Since the introduction of the telephone, a number of devices have been employed as the means of calling the attention at the distant station, the telephone itself not being sufficiently loud to be heard unless it is held close to the ear.

The first form of call instrument used, was a magneto induction arrangement, brought over to this country by Professor Bell with the telephone, it was the one then in general use in America.

In using this instrument for calling, a switch had to be moved into position, and the handle of the instrument turned. The handle acted upon a small magneto-induction machine, and so generated a current of high tension electricity, which, passing out to line, rang a polarised electric bell at the station called, at the other end of the line. One of the objections to this form of call was that persons using the telephone were very apt to omit to leave their switches in the proper position, so causing delay. To obviate this difficulty, as well as the objection to using high tension electricity, the India-rubber and Telegraph Works Company, Silvertown, introduced an automatic switch and electric bell worked by a battery; the switch was so constructed that the weight of the telephone, when in its place, always held the switch in its proper position for calling, and when taken out for speaking, the switch, having no longer the weight of the telephone on it, sprang into the necessary position for speaking through the telephone. This form of switch was also applied to the magneto calls already mentioned, as objection had been made by some persons to using a battery.

Utilising the weight of the telephone for actuating the switch has since been applied to a variety of different form of calls.

To still facilitate the use of the telephone, and do away entirely with the switch, M. Niaudet, manager of M. Breguet's works in Paris, constructed a modified form of telephone, in singing into which, or otherwise causing the telephone diaphragm to vibrate violently, the diaphragm caused intermittent contacts to be made between a battery and the line for such time as the push on the telephone was held down. The intermittent current caused a sufficiently loud noise to be given out by the receiving telephone.

This plan of using intermittent battery current as a call with the telephone has also been made use of by Mr. E. Conrad Cooke. In his arrangement, by turning a handle a succession of contacts are made mechanically between the line and battery, the effect of call being the same as in M. Niaudet's instrument.

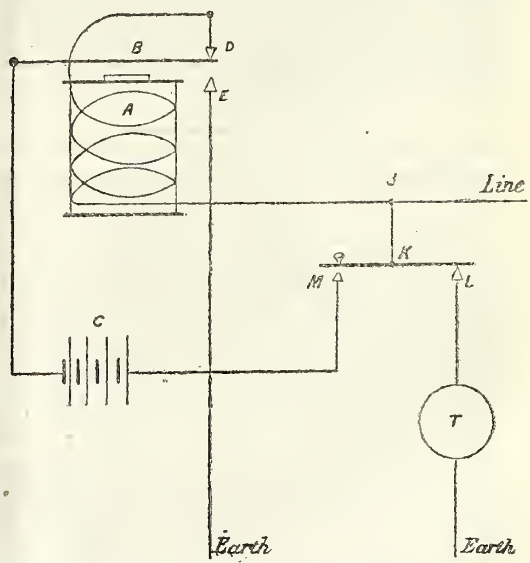
Mr. Edison, in America, has also designed two or three ingenious arrangements for telephone calls. In one of these the receiving telephone is made use of for calling attention. Upon the diaphragm one end of a light lever, pivotted at its centre, is made to rest. On the diaphragm being thrown into vibration by an intermittent battery current from the sending station, the end of the lever resting on the diaphragm receives a succession of blows, causing it to rebound, and so, it is stated, increase the sound. The telephone, when not in use for speaking, is held in a suitable stand, so that the end of the lever is resting on the diaphragm.

In order to further simplify the telephone call, Mr. A. Le Neve Foster, of the Silvertown Telegraph Works, has now perfected an intermittent battery call, which entirely does away with the switch, also the necessity of singing into the telephone, as with M. Niaudet's call, or turning a handle, as is the case with that of Mr. Cooke.

The battery and call are contained in a small box about 6 in. square. On the ordinary telephone is arranged a button, which, on being pressed, causes, for such time as it is held down, an intermittent current from the battery to flow out to line, and so acting on the receiving telephone call attention.

The call contained in the battery-box consists of a simple make and break arrangement somewhat similar to that used in causing the hammer of an ordinary electric bell to tremble. The connection with the battery and line is so arranged that by pressing the button on the telephone, the electro-magnet of the call is worked on short circuit, whilst at the same time, the whole strength of the battery is intermittently brought into connection with the line, completing the circuit through the receiving telephone, and so causing a sound to be emitted.

By reference to the accompanying diagram, the



manner in which this has been carried out will be more readily understood. In this, A is the electro-magnet of the call instrument, in front of the pole of which is placed an armature, B, such as is used for ordinary electric bells; one end of the armature is connected to one pole of the battery, the other end being free to vibrate between the contact stops, E D, the contact E is connected direct to earth, whilst D is joined to one end of the coil of the electro-magnet, A, the other end of the coil being in connection with the line, and key K at J. The key K, when at rest, makes contact with L, to which is connected one terminal of the telephone (or telephones, where two are used), the other telephone terminal going to earth in the usual manner. The

remaining contact, M, of the key is joined to the remaining pole of the battery.

Now, in order to call the attention of the distant station, on depressing the key at M, connection is made between the battery and line, whilst the connection at L is broken, so that the telephone, T, at the sending station, is now cut out altogether, but in doing this, one end of the electro-magnet coil is brought into connection with one pole of the battery, the other end being already joined to the other pole through the contact, D, and armature, B. The local circuit being thus completed through the coil of the electro-magnet, A, it now attracts the armature, B, so severing connection at D, and making it with E, but, in touching E, one side of the battery is put to earth, and as the other pole is already (by the key) connected to the line, the battery circuit will now be completed through the line and telephones at the receiving station.

It will be readily understood that, in severing the connection at D, the magnet, A, is no longer acted on by the battery, so that the armature, B, is released, a spring causing it to fly back to the contact, D, and thus, for such time as the key is depressed, a series of intermittent currents are sent through the line, these currents throwing the diaphragm of the telephone into violent vibrations, so causing a sufficiently loud sound, for ordinary purposes, to be emitted at the receiving station. This sound is far less disagreeable to the ear than the incessant chatter of an electric bell. At the same time, the whole arrangement is so simple that there is nothing at all liable to get out of order. In practice, in place of the key, K, an ordinary back contact push is used ; this can either be arranged on the telephone, or separate, as thought most convenient. The call is also so made that it can be readily screwed to an ordinary battery-box. In place of the contact stop, E, the armature, in practice, is made to strike the core of the electro-magnet, which in this case is therefore joined to earth.

PENNSYLVANIA MUSEUM AND SCHOOL OF ART.

It will be remembered that shortly before the opening of the Philadepia Exhibition, and while the preparations for it were in full progress, a movement was set on foot for the establishment in that city of a museum and art school, similar in character to our museum at South Kensington. The first report of the Board of Directors of the institution thus founded has just been issued. It gives an account of the origin of the institution and its progress down to the end of the year 1877.

In February, 1876, a charter was granted, and a Board of Trustees elected. This Board collected a considerable sum in subscriptions to be spent in purchasing objects out of the Exhibition. Twenty-five thousand dollars were thus laid out, and besides many valuable gifts were received from Foreign Commissions. Our own Commission first lent and afterwards presented the Indian collection, and gave at the outset the exhibits from South Kensington.

In January, 1877, a temporary exhibition was opened in the rooms of the Pennsylvania Academy, and in May the museum was opened in the "Memorial-hall," the permanent building of this International Exhibition, which, it may be remembered, was specially built for the purpose of a museum of industrial art. From May 10th, 1877, to January 10th, 1878, the total number of visitors was 147,113, of whom 20,280 came on Sundays.

The museum having been successfully established, the Board proceeded to turn its attention to the question of Art Teaching, and a scheme was drawn up for the establishment of classes for instruction in Industrial Art. A building in the city was obtained, the Memorial-hall itself not being sufficiently accessible for the purpose, and a notice was issued that examinations for admission into the school would be held on the 10th of December. Applicants might be of either sex, over 15 years of age. The teaching was to be free, and admission to be granted simply on the results of the examination, but those able to afford it were expected to pay a fee of twenty dollars a term. Those engaged in art industries, or who desired to gain instruction as a means of livelihood were, in cases of equality, to have the preference. Two hundred students applied, and of these one hundred, as many as could be accommodated, were admitted, fifty in the morning, and the same number in the evening classes.

At present the course of instruction in this school is elementary, and is confined to "drawing and modelling in their industrial applications," but as soon as a sufficient number have passed through the lower grades it is intended to provide "means of imparting a higher art culture and knowledge of technical design." The course is spread over three years, each year being divided into two terms, which commence respectively in September and February. The first year course is elementary, the second more advanced, and in the third, special courses such as lithography, wood engraving and carving, decorative painting, modelling, metal working, and will be arranged as may be required. There are also lectures, attendances at which, as at the classes, is compulsory for all who wish to take a diploma. Students attending merely for the sake of acquiring an accomplishment are permitted to attend certain portions only of the courses. The regulations for the students are strict, and those who at any period of their course appear incompetent, careless, or idle, are liable to be at once dismissed. The hours of attendance are from 9 to 11 for the morning classes, and from 7.30 to 9.30 for the evening classes, three days a week. Work is also required to be done by the students at home in addition to that done during class hours. The students find their own materials and retain the work they have done, specimens being reserved for the school.

A free school of art needlework has lately been established, consisting of six classes of eight pupils each. To these classes only those have been admitted who intend to make a living by their work. For paying pupils, separate classes have been formed.

So far as they have gone, the Trustees express themselves as fully satisfied with the progress made by the school, and, while they deprecate any idea of obtaining immediate results, they look forward to great future improvements in the artistic character of the manufactures of the country as likely to be the outcome of their endeavours.

ELEMENTARY SCIENCE.

The members who voted for Sir John Lubbock's motion on the 4th July, 1878, were as follows:—Bass, Arthur (E. Staffs.)—Blake, Thomas—Boord, Thomas William—Cavendish, Lord F.—Chamberlain, Joseph—Colebrooke, Sir Thomas Edward—Delahunty, James—Ennis, Nicholas—Errington, George—Ferguson, Robert—Forster, Right Hon. W. E.—Hayter, Arthur Divett—Hervey, Lord F.—Hibbert, J. T.—Jenkins, David J.—Kay-Shuttleworth, Sir Ughtred—Kensington, Lord—Lloyd, Morgan—M'Laren, Duncan—Monk, Charles James — O'Shaughnessy, Richard — Parker, Charles Stuart—Parnell, Charles S.—Pell, Albert—Playfair, Right Hon. Dr. Lyon—Plimsoll, Samuel—Ramsay, John—Rathbone, William—Smyth, Richard—Stevenson, James Cochrane—Stewart, Mark John—Swanston, Alexander—Tavistock, Marquis of—Waterlow, Sir Sydney H.—Williams, Benjamin T.—Yeaman, James.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,342. Vol. XXVI.

FRIDAY, AUGUST 9, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

PARIS EXHIBITION.—ARTISAN REPORTERS.

Arrangements have been made with the London, Brighton, and South Coast Railway Company, by which the same facilities will be given to artisans travelling to Paris, to report for the Society on the Exhibition, as have already been granted by the South Eastern and the London, Chatham, and Dover Railway Companies.

The route will be *viâ* Newhaven and Dieppe, and the fare the same as by the other lines, viz., £1.

CANTOR LECTURES.

THE APPLICATION OF PHOTOGRAPHY TO THE PRODUCTION OF PRINTING SURFACES AND PICTURES IN PIGMENT.

By Thomas Bolas, Esq., F.C.S.

Lecture IV.

Printing of half-tone subjects from metal. Application of Asser's process. Talbot's Photo-engraving. Woodbury's methods of engraving and printing.

When treating of photozincography, I gave details of Asser's process, and I showed you a zinc plate bearing the fatty image. Since then I have etched that zinc plate, so as to convert it into a high printing block, suitable for the typographic press. Here it is; here is an electrotypic cast of it; and yonder is a proof from it, hanging side by side with a proof from the unetched plate. In comparing these proofs, you will see that a little of the detail has been lost during the etching; but this is not due to any defect in the process, but to the fact that I etched the plate too rapidly. In etching a plate of this kind, the re-inkings must be done with great caution, and the acid used for the earlier etchings must be very dilute—say, one part of acid to one hundred of water.

I hope to see Asser's process come into use for large and comparatively rough work, it being well adapted for this. Mr. Dallas has brought the manufacture of typographic blocks, for the representation of half tone, to great perfection, and he has kindly lent me some of these, and also prints from them. Although we do not know what method Mr. Dallas employs in making his "tint" blocks, we can all appreciate the excellence of the results.

The illustrious Talbot discovered a method of printing in half tone by means of etched copper or steel plates, and very beautiful results have been obtained by his method, which I now intend to illustrate to you.

Here is a copper plate which has been carefully cleaned and charcoaled. I slightly warm this, and fix it on the turn-table. I next pour on it a warm solution containing six parts of gelatine, one hundred of water, and one of ammonium bichromate. The table being now rotated, all excess of the gelatine solution is thrown off, and a thin even film is left on the copper plate. The plate must next be dried at a gentle heat, after which it is ready for exposure to light under a transparency. Here is a plate which has been so exposed, and you will notice that, where the light has acted, the coating has become brown, and at the same time it has become insoluble in aqueous liquids, the degree of insolubility depending on the extent to which the light has acted. The next problem is to etch through the soluble parts of this film without destroying its continuity. This cannot be done by nitric acid, as the acid destroys the gelatine film at once, but a strong solution of iron perchloride will answer the purpose. The plate being now put into this solution of perchloride of iron, the etching has commenced. Those parts of the gelatine film which have not been acted on at all by the light remain very soluble, and allow the etching to take place rapidly, while those parts where much light has acted resist the solution altogether, and those parts which have been acted on by a small proportion of light allow a proportionate amount of the iron perchloride to penetrate. Thus all degrees of light and shade are represented by corresponding amounts of etching. The plate is now sufficiently etched. I take it out, clean off the gelatine; and now it is ready for the press. Here is a proof from a similar plate.

The next process to which I direct your attention is one discovered, perfected, and carried out on a large scale by Mr. Woodbury. The Woodbury-type process consists in casting coloured gelatine pictures in a metal mould. Here is a metal mould—the method of making it I will describe directly—in which the image is hollowed out, the depth of the hollow being greatest in those parts corresponding with the dark parts of the picture, and everywhere deep in proportion to the intensity of the shade. I place this mould in a dish containing blackened water, so that the water just runs over its face. You now see no picture or anything approaching to a picture. Now notice the effect of pressing a piece of plate-glass down on the surface of the mould. The excess of blackened water is forced out, and the hollows of the mould alone are filled up with the blackened water. Now, as these hollows vary in depth, varying degrees of shade are produced, and a perfect picture is produced. I take the glass off, and the picture disappears; put it on once more, and it re-appears. Instead of coloured water, I pour on this mould a little coloured gelatine, and press a piece of plate-glass down on the surface. The excess is forced out, and the mould filled with coloured gelatine. In a few seconds the gelatine will

have set, and I shall be able to lift off the glass, which will carry with it the gelatine image. Here it is; it forms a transparency suitable for the magic lantern. If, after having flooded the mould with coloured gelatine, a piece of paper is laid on, and the excess of gelatine is forced out with a plate of glass, a picture composed of coloured gelatine is moulded on the paper, and can be removed as soon as the mould is set. When removed, it is dipped into a solution of alum, in order to render the gelatine image insoluble in water.

So much for the general principles of Woodbury-type; and now let me show you how you can work this process yourselves.

The first thing is to dissolve about six parts of easily soluble gelatine, and two parts of lump sugar, in fifteen parts of warm water. Here is the warm mixture already strained through muslin, and here is a waxed glass plate, set level, and bordered with a little ledge of wood. The warm gelatine solution being poured on, spreads itself over the plate, forming an even layer, which, in the course of some hours, will dry, forming a uniform sheet. Well, here is a dry sheet of the gelatine on another piece of glass, and you see that the introduction of a penknife under one corner of the gelatinous sheet brings it off the glass at once. The next thing is to make this gelatine sensitive to light, and for this purpose it is soaked in a solution of potassium bichromate, containing $3\frac{1}{2}$ per cent. of the salt. You see that it has now become quite flaccid by absorbing the solution, and I now lay it on a sheet of glass, and remove the excess of solution by means of the squeegee. The bichromated gelatine adheres to the glass, but when dry it will be easily removable.

Here is a glass plate, with a dry sensitive film on it. I take the film off, and place it under a negative. It is now ready for exposure to light, and would require about two hours of such light as we had to-day at noon. Here is a printing frame containing three such films, which have had the necessary exposure under their negatives. I put these films in water, and let them get moderately soft, but not so soft as the film became during the sensitising. One of these I take out and lay face downwards on a piece of finely ground glass, another is similarly placed on a piece of glass covered with gold-beaters' skin, and the remaining one is put down on a sheet of collodionised glass. The squeegee is now applied to each, and adhesion takes place. In order to enable the gelatine films to firmly fix themselves to the supports, they should remain at rest during a period of about half an hour; but as we cannot wait that time, I have provided a duplicate set previously prepared. Mr. Barker will now put these into warm water, and the gelatine soon begins to dissolve. Now, remember that certain parts of the bichromated gelatine have been made insoluble by the action of light shining through the negative, and these insoluble parts will remain undissolved on the supports (ground glass, gold-beaters' skin, and collodionised glass). It will take some little time for Mr. Barker to wash away all the soluble gelatine, but towards the end of the lecture you will see his results in the shape of gelatinous reliefs; thick where corresponding to the blacks of the picture, very thin in those parts representing the whites, and finely graduating between these extremes. When the reliefs have been sufficiently developed, they must be dried, and here is a finished and dry set. You see that, having only one hour, it is necessary to get continually in advance of the work, and to take fresh materials which have been previously worked up to a certain stage. Let me begin with the relief on finely-ground glass. This being gently warmed, I put a border of wood round it, and pour on some fusible metal, made by melting together one part of cadmium, two parts of tin, four parts of lead, and seven parts of bismuth. Well now, if I left this to cool in the ordinary way, the top would solidify first, and the lower layers of metal in contracting would leave small vacant spaces next to the surface of the gelatine, thus rendering the cast imperfect. To obviate this, I place the glass on this cold block of metal, and cover the top of the fluid fusible alloy with warm sand. The rest explains itself—the portion of fusible alloy next the face of the mould becomes solid first. Here is a fusible metal mould made in the way I have just illustrated to you; I oil it slightly, pour some coloured gelatine solution on it, and force away the excess by means of flat glass; and when the gelatine has set, the glass can be removed, carrying with it the moulded transparency.

Here is the relief on gold-beaters' skin, and here is the one which was developed on collodion. These can easily be stripped from their glass supports, as I now show you—one corner being liberated, off they come; I will pass them round for you to look at. Now, in the actual commercial practice of Woodbury-type printing, a film relief, such as you are now passing round, is forced into a plate of lead by means of the hydraulic press, and the leaden mould thus obtained is used for printing. I now lay a film relief on the smooth steel base of this screw press, place a piece of lead on the top, and apply pressure. You see the result —the lead has become an exact counterpart of the gelatine relief, which you will notice is in no way damaged.

Here is a leaden mould, together with the corresponding relief, kindly supplied by Messrs. Braun and Co., of Dornach, and here is a very fine mould made by Mr. Woodbury himself. I will make a cast in this, and you see that the result is one of Mr. Woodbury's magnificent lantern slides, which are now so popular. It is now projected on the screen, and you can all see it. I take it out, or the heat would melt the wet gelatine, and I pass it round for you to examine, but remember that it is not yet dry, so do not touch the face of it.

I think I explained to you that, in order to get a Woodbury-type picture on paper, it is merely necessary to interpose paper between the gelatine, as poured on the mould, and the plate-glass cover, which forces out the excess. To illustrate the matter, I will print one from this mould. Now, notice the paper I use. It is thin, hard paper, surfaced with shellac, to prevent the gelatine from penetrating it, and heavily rolled, to make it even in thickness. There is much more which I should like to tell you about the Woodbury-type process, but I have not time. You will not fail to notice the admirable collection of prints

and illustrative specimens kindly lent me by the Woodbury-type Company, Messrs. Goupil and Co., Braun and Co., Bruckmann, and others, who are working the process on a large scale, not forgetting these very fine specimens lent by Mr. Woodbury himself.

I may mention that, in actual practice, one Woodbury-type printer can attend to several moulds, and by the time he has filled the last of the series, the first is ready to give up its picture. The moulds are arranged on a circular table, which revolves in front of the operator.

Mr. Woodbury has modified his process so as to obtain copper-plates suitable for deep printing in the ordinary copper-plate press, and this modification has been worked with the greatest success by Messrs. Goupil and Co., of Paris, who have kindly lent me these magnificent specimens of their work.

A gritty powder is added to the gelatinous mixture employed for making the relief, and, when the relief is made, it is found to be more or less rough, from the projection of the gritty particles. The relief is then rolled against a sheet of lead, so as to make a perfect reverse in this metal. As far as form is concerned, this plate of lead is perfectly adapted for printing in the copper-plate press, the hollows left by the projecting particles of grit holding the ink to perfection. But as lead is much too soft to be used as a deep-printing plate, the leaden plate is reproduced in copper by the electrotype process, two electrotypings being, of course, necessary, one to make a reverse mould, and a second to make a cast of this mould, or a duplicate of the original leaden plate.

HEALTH AND SEWAGE OF TOWNS.

The following are some of the communications brought before the Conference, held on the 23rd and 24th May:—

REMARKS ON THE COST OF SYSTEMS GIVEN IN THE LOCAL GOVERNMENT BOARD BLUE-BOOK ON SEWAGE.

By J. C Melliss, C.E.

In the year 1875, the Local Government Board appointed a committee to inquire into the several modes of treating town sewage, "the attention of the Board having for some time past been directed to the great difficulties experienced by sanitary authorities in devising means for the disposal of the sewage of their districts, and having regard to the frequent applications which are made to them for advice on this subject." In the following year this report was made, printed, and published. It was anxiously looked for by a very large majority of sanitary authorities, and therefore rapidly penetrated to all parts of the kingdom. The volume contains a vast amount of exceedingly valuable data collected at much trouble and expense, but the deductions drawn by the committee therefrom have not satisfied the public. They evidently do not afford that aid which was expected. The work of criticism is such an easy task, that I almost refrain from any comment; but being uninfluenced by any spirit of hostility, and guided only by a desire to see the Local Government Board continue the work which in this direction they have commenced, and by a wish to see sanitary authorities relieved from a condition of bewilderment, into which they still seem plunged, as to the most economical mode of dealing with their sewage, I would make the following few general remarks.

The committee arrive at certain conclusions from the results of their labours; and conclusions 5, 7, and 8 are as follow:—

"5. That as far as we have been able to ascertain, none of the existing modes of treating town sewage by deposition and by chemicals in tanks appear to effect much change beyond the separation of the solids, and the clarification of the liquid. That the treatment of sewage in this manner, however, effects a considerable improvement, and, when carried to its greatest perfection, may in some cases be accepted.

"7. That town sewage can best and most cheaply be disposed of and purified by the process of land irrigation for agricultural purposes, where local conditions are favourable to its application," &c.

"8. That land irrigation is not practicable in all cases, and therefore other modes of dealing with sewage must be allowed."

These constitute the pith of the conclusions, as far as they touch upon treatment of sewage by land irrigation and chemicals; and they are very generally interpreted to—and on the face of them do—favour the employment of the former method. A careful examination of the figures, as regards cost of treating sewage by land irrigation and by the employment of chemicals, given in the abstracts which accompany the report, pages xxxvii. to liv., however, will show plainly that in the majority of cases land irrigation is more costly than where chemicals are employed, so that in fact the data do not support the conclusions. This is a fact which perplexes sanitary authorities, and deters them from making progress, when desirous, as they naturally are, of obtaining what they require in the most economical way.

In reference to discharging sewage into the sea, conclusion 9 says:—

"Towns situate on the sea-coast or tidal estuaries may be allowed to turn sewage into the sea or estuary, below the line of low-water, provided no nuisance is caused," &c.

The report contains no data from places where sewage is so dealt with, and nothing to indicate to inquiring sea-side sanitary authorities that not only in some instances is such a method the most costly, but that, in nine cases out of ten, a nuisance will result.

Nearly two years have elapsed since this report was published. Its incompleteness has had the effect of encouraging local authorities in a policy of stagnation, and it does not appear that the Local Government Board have taken further steps in the matter. This is to be deeply regretted, as, considering the very large sums of money that have been spent in dealing with sewage, and the large sums of money that must still be spent, the importance of the subject cannot possibly be overrated. Much useful information is being brought together by the Society of Arts as well as by private individuals, but the Local Government Board alone possesses the power to obtain full information on this subject. It therefore rests with that Department, either as at present constituted, or

probably enlarged so as to grasp and deal with the enormous sanitary interests now committed to its care, to continue these inquiries, and, without any partiality, to enlighten sanitary authorities, and through them the ratepayers, as to the best and most economical methods to be employed, and to define what are the general local conditions which would govern the selection of one system as preferable to another.

INTERMITTENT FILTRATION THROUGH NATURAL SOIL.

By J. Bailey Denton.

Seeing that under the eighth division of the programme of the proceedings of the Conference remarks are invited "upon the costs of systems given in the last report of the Local Government Board," by which is meant, I presume, the report of the committee appointed by Mr. Sclater-Booth to inquire into the different modes adopted for the disposal of sewage, and being aware that great misapprehension exists as to the cost of preparing land for intermittent filtration through natural soil, owing to the very extraordinary figures given without explanation in that report, in relation to Merthyr Tydfil and Kendal—in both which cases I designed the works—I think it right to state that it could only be by mixing up with the preparation of the land utilised, other works which ought to have been excluded, that such extravagant figures could have been arrived at.

In the interests of sanitary science, as well as in my own justification, I desire to show that, had the expenditure been fairly investigated, the figures to which I refer would not have reached half the cost per acre given in that report. This I propose to do by giving the precise cost of a similar work executed subsequently to those of Merthyr Tydfil and Kendal—that of Abingdon, which has now been completed and in operation nearly twelve months, and I append a statement prepared by my son, in which the details are given.

Abingdon is a favourable instance of intermittent filtration combined with surface irrigation, and illustrates what may be done in many instances in the Thames Valley and other valleys where suitable soils exist.

At Abingdon, 34 acres of land have been prepared—6½ for intermittent filtration, and 27½ for surface irrigation, and the total outlay, including delivering conduit (pipes) as well as chambers and distributing earth carriers, cart roads, barrow paths and fencing, wages of clerk of works, and charges of engineer, has not exceeded £2,550, or an average of £75 per acre. The cost of preparing the land for intermittent downward filtration did not reach £85 per acre, while that of preparing it for surface irrigation cost over £70 per acre, including in each case a proper proportion of attendant charges. The soil of Abingdon is not more suitable than that of Merthyr and Kendal, yet it will be seen that the actual cost is only about one-third of that represented in the report referred to as the case at Kendal.

The deduction to be gained from the mode of disposing of sewage at Abingdon is that where intermittent filtration through suitable soil, *per se*, is adopted, one acre to a thousand people is ample to secure a perfect effluent.

Description of Works and Outlay.

By E. F. Bailey Denton, B.A. Oxon.

Abingdon, the county town of Berkshire, is situated on the Thames, and is connected with the main line of the Great Western Railway by a branch. It has a population of a little above 6,000, and a rateable value of about £14,750. Geologically speaking, the town is situated on the Kimmeridge clay at its junction with the coral rag of the oolite. Its position is comparatively low, the surface of the lower portion of the town being very little above the level of the river, while the remainder rises so gradually as to render it necessary to lift the whole of the sewage.

A complete system of water-tight sewers has been carried out for the whole of the town, and the surface waters are excluded from them as far as possible, with arrangements for flushing from the Thames, Ock, &c., at intervals. The sewage is conveyed from the town to the land to which it is applied, by an outfall sewer, which is sufficiently capacious to hold any liquid admitted into it during the night, when the lifting of the sewage is discontinued.

The sewerage, including this outfall sewer, and engineer's charges, but excluding private sewer-connections, has been executed for £8,750.

At the mouth of the outfall sewer a pumping station is erected on the land purchased by the urban sanitary authority, fitted with two 8-horse-power engines, together with coal shed, &c., at a cost of £2,500. In this amount is included the fencing of the station yard and a weighing machine, which serves for the weighing of the coal consumed by the engines, as well as the produce of the sewaged land as sold. Both these sums, amounting to £11,250, include engineer's charges, clerk of works' wages, and incidental expenses, and if repaid in 30 years at 5 per cent. would represent an annual charge of £562 10s., or less than 9¼d. in the £ on the rateable value.

The cost of the coals, and the wages of the engineman, with proper allowance for sundries, amount to £150 a year, which is equal to 2½d. on the rateable value, making the whole charge for sewerage rather less than 11¾d. in the £.

The amount of sewage at present discharged is somewhat above 100,000 gallons daily, augmented on occasions of rainfall, and at those times when the flushing of the sewers takes place.

At present, however, the water supply to Abingdon is obtained from the rivers Thames and Ock, and from private wells, and the quantity of sewage proper is less than ordinary, but steps have been taken, and plans are already made, to provide a public supply for the town at an estimated cost of £7,250. When these works are executed, a greater number of water-closets will be introduced, and the quantity of sewage will, doubtless, be increased.

The land selected for the cleansing of the sewage, and purchased by the urban authority, is distant half-a-mile from the town. The soil is a free drift lying upon the clay in which the subsoil water is now kept down by under-drainage to a level with the water in the river. Until the under-drainage was effected, the subsoil water would rise, after continued wet weather, to within a foot or two of the surface. The quantity of land pur-

chased by the urban sanitary authority for sewage treatment is between 48 and 49 acres, of which only 34 acres have been laid out for sewage treatment. The rest, consisting of river-side meadow, is let as accommodation land, but it will be available to receive the sewage when experience has proved that its utilisation can be profitably effected. The cost of the 48 acres, including tenants' compensation and all expenses, has been £7,260. The cost of preparing the 34 acres of land to cleanse the sewage has been £2,550, including the payments to engineer and clerk of works. This is equal to an average outlay of £75 per acre. Of the 34 acres composing the sewage farm, $6\frac{1}{2}$ acres were laid out for intermittent filtration, and $27\frac{1}{2}$ for surface irrigation, and the £2,550 covers not only the preparation of the land, but the making and metalling of cart-roads and barrow-paths for the removal of produce, &c., and the erection of iron fencing, together with pipe conduits and sluice chambers to all parts of the land, and the necessary distributing earth carriers. The cost, per acre, in preparing the filtration land, which is divided into five equal horizontal areas, including under-drainage and a proportion of all other expenses, was a little under £85 an acre, while the cost of laying out the land for surface irrigation, including its proportion of all other expenses, was as much over £70 an acre. Two areas out of the five serve as "the safety valve," and receive the whole of the sewage for a year when it is not wanted elsewhere.

Beyond the cost of preparing the land, the urban sanitary authority have erected a pair of cottages, one for the engine-man, and the other for the farm bailiff, together with a small set of farm buildings, at a cost of £1,075, including engineer's charges, &c.

Thus the land and its preparation, with the two cottages and farm buildings, have cost the urban sanitary authority £10,885; but for this money they possess a small farm and steading, for which they could realise at any time about half the outlay if sold by auction. The farm is in the hands of the urban sanitary authority, but tenders for the renting of it with the sewage are being sought, and as $2\frac{1}{2}$ acres of the filtration areas alone suffice to cleanse the sewage, and the occupier can utilise it as and when he wants it on other parts of the farm without any trouble whatever, and without any doubt as to purification, it may be fairly assumed that the future rent of the 48 acres will not be less than £250 a-year, and may very likely be more.

At Abingdon there is no separation of the "sludge" from the liquid before it is applied to the land for purification. Whatever passes the screens, and is raised by the pumps, is distributed over the surface when the sewage is used for irrigation, or by the furrows when it is used for filtration, and no difficulty whatever is experienced in either case, nor is any smell perceptible at a distance of 20 yards. So far from any difficulty or objection having been experienced from the retention of the "sludge" in the sewage, the farm bailiff complains that he has not sludge enough, but that the liquid is absorbed by the land too quickly. Two hours after the cessation of pumping, no sewage liquid is to be seen on the farm.

During the period in which the sewage has been applied, one area of land has sufficed to absorb for days together the whole of the 100,000 gallons lifted by the engines, and this has been the case without the least sign of the land having too much, and without producing any injurious effect upon the effluent. As already intimated, the arrangement now made is, that two out of the five areas laid out for intermittent filtration (or $2\frac{1}{2}$ acres out of the 34) shall be always in reserve to receive and dispose of the sewage when it is not wanted on other parts of the farm. These two areas will continue to act as the safety valve during the year 1878, after which period two other areas will take their place (for 1879), and so on.

The effluent water discharged by the under-drains from the sewage land has been analysed by both Dr. Tidy and Dr. Woodforde. Dr. Tidy says of it, that it "was in every respect excellent. The quantity of common salt was not more than four grains per gallon, and it was perfectly clean and bright when run in large bulk;" and Dr. Woodforde states, that his analyses showed that the quantity of albuminoid ammonia which the effluent contained was not more than double that contained in London drinking water, while its condition generally was far superior to that of certain shallow wells at present used for domestic purposes in Abingdon.

WHETHER ANY FURTHER LEGISLATION OF A COMPULSORY OR PERMISSIVE CHARACTER IS NEEDED FOR BRINGING ABOUT A BETTER SANITARY CONDITION OF TOWNS OR DWELLINGS?

By Henry Robinson, C.E.

Those who have had much experience in advising local sanitary authorities will agree that the Public Health Act of 1875 is not accomplishing, to the extent that it is capable of, much improvement in the sanitary condition of the smaller towns, and of the rural population; so far, at least, as relates to questions of drainage and water supply, with which subjects the writer has been more directly concerned.

At a time like the present, when it is proposed to amend the Act, which implies that its provisions are unequal to the sanitary requirements of the country, it may be useful to consider whether the unsatisfactory outcome of the operations of this Act is due to defects in the Act itself, or whether it arises from neglect and obstructiveness on the part of the local authorities, or from inefficient administration at the Local Government Board.

The Public Health Act of 1875 gives the Local Government Board abundant power to compel reluctant local authorities to improve whatever is defective in either their drainage or water supply. Clauses 293 to 304 inclusive define these powers, and it is difficult to conceive that these clauses were not intended to be put in force by the Local Government Board itself. Experience, however, shows that these powers practically lie dormant, and no initiative is taken to set them in motion; in fact, until an epidemic breaks out, it may be safely stated that, in the majority of cases, the local authority takes no serious step towards discharging the duty imposed by the Act, by inquiring into the sanitary necessities of their districts

as to drainage and water supply; nor does the Local Government Board interfere to see that this duty is not left unperformed, although one important duty of this department is regarded by the public as consisting in keeping sanitary authorities up to their work.

The sanitary authority is frequently so constituted, that those members of it who take an interest in, and recognise the duty imposed on them as to, sanitary improvements, are opposed by a majority who are openly elected to keep down the rates, and who obstruct all efforts to carry out the requirements of their district. There is no real obligation on the authority to comply with the obvious intention of the Legislature that it shall ascertain what are the pressing wants of its district, and shall adopt such measures as the case requires, as it is known that nothing of a compulsory nature will be done unless the attention of the Local Government Board is drawn to the place by neglect or indifference having been carried so far that an epidemic breaks out.

In every case the local authority is tempted to do nothing, unless under strong pressure, which the medical officer or inspector of nuisances is expected by the Act mainly to be the means of exercising. If they do their duty it is under great disadvantages, as their appointment is dependent on the pleasure of those whom they are expected to influence, to the extent, even, of bringing the powers of the Local Government Board into operation, thus naturally entailing a hostile feeling against themselves.

Clause 299 of the Public Health Act of 1875 says:—

"Where complaint is made to the Local Government Board that a local authority has made default in providing their district with sufficient sewers, or in the maintenance of existing sewers, or in providing their districts with a supply of water, in cases where danger arises to the health of the inhabitants from the insufficiency or unwholesomeness of the existing supply of water *and a proper supply can be got at a reasonable cost* (the italics are the writer's), or that a local authority has made default in enforcing any provisions of this Act which it is their duty to enforce, the Local Government Board, if satisfied after due inquiry that the authority has been guilty of the alleged default, shall make an order limiting the time for the performance of their duty in the matter of such complaint."

It will be noticed that, before any complaint can be justified as to the water supply being dangerous to health, the authority has to be convinced that a supply of pure water can be got, and at a reasonable cost. This involves both medical and engineering knowledge, and the authority, when disinclined to move, can, and invariably does, raise difficulties by which the evils are left, without any effort to remedy them, until an epidemic sacrifices a sufficient number of lives to bring down the authority the Local Government Board. It was stated by Dr. Frankland, F.R.S., last March, before the Select Committee to amend the Public Health Act, that about 12,000,000 people in this country derive their water from shallow wells, the water being "generally unwholesome; it is largely polluted with sewage, and, in fact, it may be stated generally that, as a rule, the rural population amongst whom we went were substantially drinking their own excrement." It was also stated by the chairman of that committee, and concurred in by Dr. Frankland, that typhoid fever is on the increase in this country.

Having in view the admittedly dangerous condition of so large a population, it would not be thought that any amendment of the Public Health Act of 1875 would have been satisfactory, which did not strike at the root of the evil, and present the possibility of the continuance of local obstructiveness or of passive acquiescence at head quarters. The Public Health Amendment Bill, as amended by the Select Committee, deals with the question of an improved water supply, and states in the preamble:—

"Whereas the provisions of the Public Health Act, 1875, are inadequate to secure a proper and sufficient supply of water, especially in rural sanitary districts, and it is accordingly expedient that these provisions be amended."

Clause 2 states: "It should be the duty of every rural sanitary authority to see that every occupied house within their district has, within a reasonable distance, a supply of wholesome water sufficient for the consumption and use for domestic purposes of the occupiers of the house."

"Where it appears to a rural sanitary authority, on the report of their inspsctor of nuisances, or their medical officer of health, that any occupied house within their district has not such supply within a reasonable distance, and the authority are of opinion that such supply can be provided at a reasonable cost, not exceeding a capital, the interest on which, at the rate of 5 per centum per annum, would amount to twopence per week, or at such other cost as the Local Government Board may, on the application of the local authority, determine under all the circumstances of the case, to be reasonable, and that the expense of providing the supply ought to be paid by the owner or made a private improvement expense."

It will be seen from these clauses that there remains the same opening for obstructiveness or indifference as in the past, and although many new and useful provisions are included in the Bill, which would remove some difficulties, the main point is still not gained, clause 2 leaving things practically as they are as regards bringing into operation the means of enforcing the provisions of the Bill. After the inspector of nuisances, or the medical officer, has reported to the authority, it has first to consider whether the alleged want of wholesome water is well founded; secondly, as to the reasonableness of the distance from a supply of wholesome water; and then as to the reasonableness of the cost of supplying the pure water to the inhabitants. Until all these conditions are clearly brought home to the minds of the authority, the inhabitants are left to continue to drink their foul water, and typhoid fever is left to claim its increasing number of victims.

The remedy, in the writer's opinion, is to leave less to the initiation of the local authority, and to require the Local Government Board (by further legislation, if such is needed) in the future to see that the Act is carried out in reality. Also in order to provide a remedy against the local officer being dependent on the authority, there should be a central medical (or other) officer appointed, having authority over the district, to whom the local medical officer, or nuisance inspector, should report (besides reporting to the authority), and that this chief officer should have power to act in cases of

emergency, and where the public health is jeopardised, without previously obtaining the consent of the sanitary authority, of whom he would be independent.

Clause 293 of the Public Health Act of 1875, already gives the Local Government Board power to interfere, if it were only acted on. The clause is this:—

"The Local Government Board may from time to time cause to be made such inquiries as are directed by this Act, *and such inquiries as they see fit in relation to any matter concerning the public health in any place*, or any matters with respect to which their sanction, approval, or consent is required by the Act."

The italics are the writer's, and it is difficult to propose words which could give wider powers to the department, if they were only put in force, which they are not.

The President of the Local Government Board stated in the House of Commons, this Session, that recent legislation on the subject had scarcely yet been allowed time to work, and that he saw no reason at present to seek for further compulsory powers on behalf of his department in reference to local authorities. It is to be hoped that a discussion at this Conference will tend to make the existing compulsory provisions of the Public Health Act operative, and to even increase them by the Amendment Bill (not, however, as non-drawn) to the fullest possible extent, as the time has arrived for the adoption of strong measures.

THE NECESSITY FOR LEGISLATION EMPOWERING URBAN SANITARY AUTHORITIES, TO PREVENT THE PROPRIETORS OF HOUSES, ERECTED BEFORE THE CONSTITUTION OF LOCAL BOARDS, FROM BUILDING UPON THE WHOLE OF THE OPEN SPACE BELONGING TO SUCH HOUSES.

By Henry J. Yeld, M.D., F.C.S.,
Medical Officer of Health, Sunderland.

The Corporation of the borough of Sunderland, in 1866, anticipated the Artisans' Dwellings Act of 1875, by obtaining an Act of Parliament, enabling it, by an improvement scheme, to deal with a large amount of old property, which, from various causes, was unfit for human habitation.

The Town Council has spent some £80,000 upon that scheme, by means of which all the old fever dens, close lanes, and alleys, have been swept away. New, broad streets have been made, improved dwellings built, and the death-rate of that portion of the borough reduced from 30 to 22 per 1,000.

The Artisans' Dwellings Act of 1875 gives power to urban sanitary authorities to deal with a class of property in other large towns, similar to that dealt with under the provisions of the Sunderland Town Improvement Bill, and the results likely to be obtained, by the carrying out of that Act, cannot but be of immense advantage to the public welfare in every respect. At the same time, a new source of danger to the public health is likely to be produced, unless that portion of the Public Health Act of 1875, relating to the erection of new buildings, is either altered or amended.

This new source of danger is not an imaginary one, but one which, I think, should be carefully considered and, if possible, prevented; it is this:—

That, whilst every facility is now given to local authorities by the Legislature for dealing with properties which, by reason of want of light, air, ventilation, and from other causes, are unfit for human habitation, and also for making bye-laws to regulate the building of new properties, in which provision can be made for a certain amount of space adjoining each house to be left for open-air space, no such provision is made whereby such authorities can deal with properties built before Local Boards were constituted; so that, unless some such provision be made, large sums of money may be spent on an improvement scheme in one part of a borough, whilst at the same time, in another portion of the same borough, a condition of things may be gradually coming into existence, similar, in many respects, to that which in the first instance made it necessary to put the Artisans' Dwellings Act into operation. These remarks apply more especially to municipal boroughs, incorporated within the last forty years.

In the borough of Sunderland, scarcely a Council meeting passes at which plans are not passed, allowing owners of property to build upon open spaces attached to properties built before the Corporation came into existence.

The local authority is at present powerless to prevent such additional building going on. Some few years ago the Council brought an action to test their power in this respect, when the verdict was given against them, it being held "That the building was not a new building within the meaning of the Act, but only an addition to an old building."

I think I have shown sufficient reason that it is at least desirable that some power should be given to local authorities, to prevent the whole of the open-air space belonging to old dwellings from being built upon. No doubt there are difficulties in the way of making laws or bye-laws which shall be retrospective in their operation; such difficulties, however, could be fairly met and overcome.

ON SOME DEFECTS IN THE PUBLIC HEALTH ACT AMENDMENT BILL, AS AMENDED BY THE SELECT COMMITTEE OF THE HOUSE OF COMMONS.

By F. T. Bond, M.D.

No one who has made himself acquainted with the details of the Public Health Act Amendment Bill, as altered in Committee, can fail to see that it is a measure of far greater public importance than its somewhat unobtrusive title would seem at first sight to indicate. It is not too much to say, that if the Bill becomes law during the present Session, and if the work which it foreshadows in rural districts can be carried out, it will do more to improve the condition of the poorer classes in these districts in respect to health, comfort, and decency than any enactment which the Legislature have passed for some time. Moreover, the Bill is an excellent illustration of the way in which the numerous defects and shortcomings of the Public Health Act may be dealt with in a practical way

by taking special sections of it which relate to separate subjects, and making a careful inquiry into the legislative amendments which are needful and practicable in regard to them. Such amending Bills have a reasonable prospect of passing through Parliament, even when not undertaken by the Government, where a Ministerial measure for the amendment of the whole Act would have but a remote chance of successs.

The machinery which the Public Health Act Amendment Bill—which it is only needful to say, relates chiefly to water supply—provides for the discovery of cases of insufficient supply of water in rural districts, and for the rectification of such defects where their existence is satisfactorily established, is excellent up to a certain point. The owner of a house which is not provided with a supply of drinkable water within reasonable distance, can be compelled by the sanitary authority to provide such a supply, if it can be obtained at a reasonable cost, or at one which represents the capitalised value, on an average, of the water-rate which such an owner can be obliged by the law at present to incur for a house where a system of public supply by pipes exists. The only remark which I have to make on this provision, is to express the hope that the President of the Local Government Board may look more favourably on it than he did three years ago, when Mr. Ernest Hart and I strongly pressed it on his attention in an interview which we had with him on the subject whilst the Public Health Act was passing through Parliament. He appeared at that time to view such a clause as equivalent to a confiscation of a large proportion of the cottage property in the country, and to think that it was improbable that the House of Commons would sanction it.

The next step which a sanitary authority is empowered to take, is the natural sequel to the first, and has been evidently suggested by the provisions which the law at present makes in regard to allied matters, such as drainage and closet accommodation, viz., that where the owner of a house neglects or refuses to do the work which he is thus called upon to do, the sanitary authority may do it for him, and may either recover the cost from him by summary procedure, or may charge it upon the premises as a private improvement expense, for which the authority is empowered to levy a special rate. Now, it is at this point that it seems to me that a hitch is likely to occur in the working of the machinery created by the Bill. There is no doubt that there is a large number of cottages to which its provisions are applicable, which belong to owners who are worth the powder and shot of legal proceedings to recover the cost, which the sanitary authority may incur in remedying their default. In such cases the course of procedure will be very simple, and sanitary authorities will have no inducement to refrain from adopting it on account of either of the risk or the trouble in which it may involve them. But everyone who knows much of rural districts must be aware that a very large, possibly the largest, number of houses which will thus require the office of the sanitary authority to be promoted on their behalf, either belong to owners who are so utterly impecunious as to be unable to provide the means which will be necessary to carry out the works required by the sanitary authority, or their ownership is so tied up amongst several holders, with varying degrees of interest, that it is practically impossible to get them to do anything, and the sanitary authority must do it on their behalf.

Now, the first point which suggests itself here is to inquire whence the capital is to come, which will be required to pay for the works which sanitary authorities will thus have to carry out. The aggregate amount which will require to be spent in many rural districts within the course of the first two or three years after the passing of the Bill, if its provisions are to be put efficiently into force, will be very considerable, reaching, probably, in the case of large districts, to many hundreds of pounds. This money will have to be provided directly the works are commenced, so that they may be paid for, according to common practice, as soon as completed. On the other hand, the sanitary authority will, even under the most favourable circumstances, be unable to realise the cost of the works at once from the owners of the houses, and may have to stand out of it for two or three years.

So far as the Bill runs at present, there appears to be no alternative, but for the sanitary authority to raise the sums required for these works by rate. Now, although this rate will only be a temporary one, and although the amount raised by it would be eventually repaid, so that the district from which it is raised would not, in the long run, be at any loss from it, it is very desirable to avoid having recourse to it, if it be possible to do so, since the rural mind is much more ready to apprehend the mere intention of raising a rate, and to resent it, than to grasp the fact that such a rate would be only a loan on the part of the district to the owners of the property benefited.

There is, however, one provision which may be suggested as being calculated to meet this difficulty, and which might even create a desire on the part of sanitary authorities to carry out energetically the provisions of the Act, and that is, to enact that where the cost of the contemplated works is proposed to be defrayed by a private improvement rate, the sanitary authority may, in making the rate, add to the sum assessed on the premises for the repayment of the cost of the works, such additional sum as may be required to pay interest on the capital borrowed for carrying them out. At what rate such interest is to be estimated is a subject for discussion. It certainly should not be less than the sanitary authority would itself be required to pay if borrowing the money from the Public Loan Commissioners, or in the open market; and there are good reasons why it should be more. For what is the reason for which this expenditure is required to be incurred? It is to remedy the *lâches* of the owners of property, who, by neglecting to do their duty towards their tenants, compel the sanitary authority to put pressure upon them to do so, at some trouble to itself, and at some expense to the other property owners in the district who have committed no such default. It is only fair, therefore, that if the money required in order to rectify these shortcomings of landlords has to be borrowed by rates imposed for a time on the other inhabitants of the district, the latter should be compensated, by not only being paid the loan back in its entirety, but with such interest as

would cover use of the money itself, together with a contribution to the general expenses of the sanitary authority. If such an arrangement were made, and a landlord were required to pay, say six or seven per cent. on the cost of the works executed in thus improving his property, he would be no loser by the transaction, and the sanitary authority would be a distinct gainer. I believe that if this principle were extended to sanitary improvements of all kinds, *i.e.*, if sanitary authorities were empowered to themselves undertake works for the sanitary improvement of cottage property, and to charge private improvement rates, which would not only cover the cost of the improvement, but would leave a moderate margin for the benefit of the authority itself, a large field would be opened for the improvement of such property throughout the country, which both authorities and the owners of such property would be glad to cultivate.

The advantages of such an arrangement would be obvious. It would place local authorities in the same relative position with regard to the owners of property in their own district as the Public Loan Commissioners, representing the nation, now hold in regard to the authorities themselves by giving such owners the help of the general commercial credit of the authority upon which to borrow money for the sanitary improvement of their property, just as the authorities now avail themselves of the credit of the nation for the same end in regard to their schemes; with this important difference, that the sanitary authority, being on the spot, would be able to exercise a more efficient control over the expenditure of the money which it could lend than the Public Loan Commissioners can.

There is, however, another possible solution of this difficulty which may be suggested, and that is that the sanitary authority should be empowered to borrow the money required for carrying out these works directly from the Public Loan Commissioners—in the same way as it can do at present in the case of schemes of large extent. If this were done, it would, of course, be necessary that such loans should be applied for in lump sums, say of not less than £100 each, the re-payment of which would be chargeable on the rates of the contributory district as a whole, which would in its turn be recouped by the improvement rates levied on the property specially benefited. Such an arrangement would appear to be only a reasonable extension of the practice as referred to above, for it is difficult to see why if the owner of a house in a town is allowed to borrow, through the medium of the sanitary authority, from the nation at large, the capital required for supplying his house with water, as he can do at present, the owner of a similar house in the country should not, under similar conditions, be permitted to enjoy the same benefit.

The suggestions which I have made in the foregoing part of this paper refer primarily to the case of isolated cottages, or of small combinations of not more than two or three together belonging to one landlord; but their applicability becomes much stronger where the groups which require to be dealt with embrace some dozen or two houses, belonging, as is so often the case, to different owners. In such cases it would be only practicable to deal with the matter in one way, viz., for the sanitary authority to do the work, and to recover the cost by private improvement rate. So far as my own experience goes, the work which would require to be done under the Act would mainly come under this latter category. Now, in addition to the difficulty connected with raising the capital required for works constructed for supplying water to such groups of cottages, there is another, which does not seem to have suggested itself to the committee who have had the Public Health Act Amendment Bill under consideration, but which, I venture to think, will be found a rather serious one when it comes to be put into operation. It is this: in whom are works constructed by the sanitary authority (under section 2, sub-section 5) for the common benefit of a group of houses belonging to different owners to be vested? As the Bill stands at present, the ownership of such works would be in common amongst the owners of the houses. A very little reflection will, however, convince anyone, I think, that such an arrangement would be a most unsatisfactory one. Wells require cleaning; pipes, pumps, and other mechanical contrivance, require constant looking after and mending. How can a heterogeneous body of landlords be expected to undertake such a duty? And if they fail to do it, as they certainly will in nine cases out of ten, what endless trouble will be entailed on the sanitary authority in making them do so! The simple remedy for this difficulty obviously is, to vest the custody, at any rate of all works constructed for the benefit in common of two or more houses, in the sanitary authority, and to empower it to levy on such houses such a rate as will be sufficient to cover the expense of providing for the proper maintenance of the works.

I believe that if the provisions which I have thus suggested were incorporated with the Bill, they would not only remedy defects in it which will, I fear, if not removed, greatly interfere with its practical success, but that they would make it a model on which to re-mould other portions of the Public Health Act, and thus greatly to facilitate the much-needed amendment of the Act.

ON TIDAL SEWAGE-OUTFALLS.

By James N. Shoolbred, Mem. Inst. C.E.

With a feeling of disappointment the writer perceived at last year's Sanitary Conference, held under the auspices of this Society, that there was no communication whatever upon this important branch of the sewage question. For it is one that, though so far it has drawn but little attention to itself, yet it is gradually forcing itself upon our attention, and is growing in importance; and from several reasons.

The subject of tidal outfalls, in the first instance, presents itself naturally to towns and cities situate, either upon the sea itself, or upon rivers affected by the tide. But, in proportion as the custodians, or conservators, of our large rivers become each day more stringent in preventing sewage and polluting matters from being poured into those streams, so will the authorities of the towns on the banks of the upper, or fresh water, portions of those streams have to look for other outlets for their sewage; at least, in its undiluted condition.

So that a time may come (though it is still in the distance) when one or more towns or districts on the fluvial portion of a river may combine, in order to carry away their sewage down to a point where it may be permitted to be discharged into the tideway, or into the open sea. Thus, some of our large rivers may come to have a sewage carrier along one, if not along both banks (as is the case in this metropolis), for a considerable distance down their course.

Again, several of the towns on the coast, such as Hastings, Brighton, Southport, and other watering-places, where it was essential to keep the shore free from all suspicion of pollution, have already constructed, at considerable expense, large intercepting conduits, to convey away to a distance the contents, which their original outlets emptied into the tideway directly in front of the localities themselves.

The controversy going on between the Thames Conservators and the Metropolitan Board of Works, as to deposits of sewage in the Thames in the neighbourhood of Woolwich, is a matter of notoriety; as is also the proposal to convey the sewage of Glasgow some distance away beyond the mouth of the Clyde, where it might flow direct into the open sea. The town of Dublin has also been crying out very warmly for some time back about the filthy condition of the Liffey; while the inhabitants of Liverpool and of Birkenhead have long complained of the fouling of the bathing places and sea-side resorts in the neighbourhood by slimy deposits of sewage; and their complaints are registered as far back as 1869, in the first volume of the Report of the River Pollution Commissioners.

For these and other reasons, is this question of tidal outfalls for sewage gradually forcing itself, and in an unwelcome manner, upon our notice.

It is, therefore, not inopportune, that in this place and at this meeting, this branch of the sanitary question should begin to have its due consideration assigned to it, and an approximation, at least, arrived at as to the principles upon which those tidal outlets for sewage should be based. The radical error hitherto very generally made in the position of these outlets, and the cause of the costly intercepting culverts already referred to, has been due to a misconceived notion as to the action of the tide; to a confusion of ideas between the tidal impulse, which of course passes on never to return again; and the movement imparted by it to the water, and which is the result of the passage onward of this tidal impulse.

The particles of the water, successively finding themselves under the influence of this progressive force, start along in direction with it, and endeavour, but in vain, to keep pace with it. Gradually, as they lose the influence which has dragged them along with it, the force of gravity predominates with them, and they retrace their steps backwards, descending the inclined plane they had previously ascended, till they reach near to their original position, again to come under the influence of the succeeding tidal wave and be re-impelled forward once more. Hence the movement of the water under the tidal influence is one of constant oscillation; the length traversed being in the tidal rivers and shallow seas of our coasts more intensified and more marked than in the open ocean.

That the tidal impulse, or tidal wave, as it is more generally termed, and the movement of the water, its influence, are totally distinct from one another, may very readily be seen. A mere inspection of a map giving the times of high water along our coasts, or marking the cotidal lines, will show that the progress of the tidal wave, under ordinary circumstances, is at the rate of hundreds of miles per hour, while nowhere does the speed of the water, happily, exceed some six to seven, or eight, miles per hour.

From these remarks it will be seen that the discharged sewage, instead of being carried away never more to be heard of, as some had fondly hoped would be the case, becomes subjected to this oscillating action of the tidal water. Under this influence the solid portions, after a certain period, gradually are deposited in a slimy, gelatinous, disintegrated form in the quieter nooks and bays of the shore, somewhat removed from the more active part of the current. From this gradual deposition result the offensive smells, and thence the long and costly intercepting outfall conduits in the more fastidious and sensitive of our watering places. Similar results will undoubtedly follow elsewhere, and, therefore, some remedy or palliative should be sought for, in order to postpone at least, if not to prevent, similar disastrous effects.

The first and apparently the most natural precaution to take, to prevent these ill effects, lies in the selection of the position of the outlet mouth; which should, if possible, be into a part of the tideway, where the direction of the current is not parallel to the line of the coast, but somewhat deflected from it, so that the sewage in its oscillatory travels may not be brought back upon the shores whence it issued. But this, and numerous other circumstances, require in each case a special study of each individual locality; too long to be discussed here. Enough, however, has been said to show that this question of tidal sewage outfalls is one worthy of attention, and one which is daily growing in importance.

A river into which the tide enters, and which has populous towns upon its banks, situate upon the tidal as well as upon the fresh water portion of its course, becomes, with the prevailing system of water-carried sewage, itself a large sewage outlet into the sea. The magnitude of its fresh water current and the proportions the polluting matters bear to its waters depend very largely upon the area of the water-shed upon its rainfall, together with the geological and other physical conditions, or, in other words, upon the size and formation of the river basin belonging to it.

The Congress recently held here on National Water Supply have in their resolution requested, and apparently with much judgment, the Council of the Society of Arts to memorialise the Government to collect information on the subject of the sources of supply which are available, and to adhere to the river basin as the unit of classification for such information.

It would likewise appear, in the writer's opinion, to be equally fitting, that information as to that portion of the rainfall, which is polluted and rendered unfit for use by sewage and other matters, should also be collected, as a supplement to such water-source information, and, like it, should be arranged under the various water-shed areas.

MISCELLANEOUS.

REPORT ON THE ROYAL GARDENS, KEW, FOR 1877.

Sir Joseph Hooker's report on the progress and condition of Kew-gardens, although appearing so late in the year, contains much matter of a kind likely to be interesting to the readers of the *Journal.* Regarding the introduction of useful plants into countries other than those of which they are native—a work in which the real usefulness of Kew-gardens as a national establishment stands prominently forward—a good deal is said under the head of "Interchange of Plants and Seeds." It is here, as well as under the head of "Official Correspondence," that the most valuable portions of the report are to be found. Plants valued for medicine, food, or manufactures are here treated of. Amongst the first, Sir Joseph Hooker reports that, of the five seeds of the Para balsam of copaiba plant (*Copaifera multijuga*), brought by Mr. Cross from the forests of Para, which germinated, only two have been reared, and these grow with extreme slowness. If these two plants should be successfully preserved, it is hoped that, in course of time, a stock may be propagated from them for transmission to India. Regarding the successful cultivation of cinchonas in Jamaica, where the plants have been introduced for more than 10 years, Mr. Thomson, the superintendent of the Botanical-gardens in that island, writes, under date of November 8th last: —"We have now nearly ready for shipment about 3,000 lbs. of cinchona bark." This, we are reminded, is the first crop from the existing plantations. *Cinchona succirubra* grows most rapidly; *C. calisaya* also does well, but *C. officinalis* assumes a shrubby aspect of growth, and will probably have eventually to be superseded by the other kinds. It is satisfactory to read Mr. Thomson's further remarks as follows:—"It has been abundantly proved that several species of cinchona are eminently fitted for cultivation in Jamaica. The enterprise has emerged from the purely experimental state, and can now be carried on as an established agricultural industry." The new cinchona febrifuge, which has been prepared in India in large quantities from the bark of *Cinchona succirubra*, grown in the Government plantations at Darjeeling, and which is described as containing "all the febrifugal alkaloids of that species, in the relative proportion in which they exist naturally in the bark," is issued by the Government of India as a cheap and efficient febrifuge for the poorer classes. It is said to be "not intended to do duty as more than an antiperiodic, and for other purposes it cannot be regarded as a substitute for quinine, since the physiological action of some of its probable constituents, such as aricine, is emetic and unpleasant."

The reports from India of the cultivation in that country of the ipecacuanha plant (*Cephaelis ipecacuanha*), originally a native of Brazil, and, like the cinchonas, a medicinal plant of very great value, are not reassuring, though plants have been distributed by Dr. King from the Calcutta Botanic-garden to Ceylon, Singapore, Burma, and the Andamans. Dr. King's remarks on this subject are as follows:—"The peculiarly slow growth of this plant tends to prevent the cultivation of it from being taken up with spirit by European planters. . . The insignificant straggling appearance of the plant is, besides, little calculated to excite enthusiasm, or even interest, among the planting community." Sir Joseph Hooker suggests that as the profitable cultivation also appears hopeless at the Cinchona plantation, "owing to the cold of the winter season," it may be worthy of consideration whether the Indian Government would not do well to establish a nursery in some part of the British Indian possessions with the tropical climatic conditions necessary for its growth. In connexion with this suggestion, a letter is quoted from the superintendent of the Botanic-garden, Singapore, in which he states "that he is endeavouring to induce the Government to take up ipecacuanha cultivation in the native States, believing that both the climate and soil of Perak and the neighbouring States are well adapted to its requirements." Application has been made to Dr. King, of Calcutta, for a detailed account of the mode of propagation and cultivation carried on in Sikkim, which it is intended to print and circulate amongst the planters.

Food-producing plants, whether regarding their cultivation or the diseases to which they are liable, are largely treated of in the Kew report. Of the chocolate or cocoa plant, for instance, it is said that in Ceylon the cultivation is being prosecuted with energy by the planters, and the seeds of the best varieties are largely imported into the island from Trinidad. Regarding the Liberian coffee, which, in the preceding year to that under review, was distributed to most of the colonies as well as to other parts of the world, and whose merits are stated now to be established, seeds were sent last year to Demerara, Grenada, Honduras, Jamaica, Mauritius, Seychellas, Singapore, United States, and Zanzibar. Sir Joseph says, "In only one case can the despatch of the Liberian coffee from Kew be said to have been wanting in success. Repeated attempts to send the living plant in the ordinary way to Queensland have uniformly failed, and a correspondence has taken place with the Queensland Government upon the subject. That the failure is due to the accident of a prolonged and extremely trying voyage is conclusively proved by the following facts. On September 18, 1876, Mr. H. A. Wickham took from Kew, in his personal charge, to Townsville, Queensland, a Wardian case, containing 175 seeding plants of Liberian coffee, which arrived in good condition on February 18 of the following year. Precisely similar Wardian cases, each containing the same number of plants in the same condition, were despatched also from Kew, on the same day, to the Queensland Acclimatisation Society and the Brisbane Botanic-garden, and of both the contents arrived entirely dead. It is therefore clear that the voyage in itself is not necessarily fatal to the plants, but that they are killed by exposure to unfavourable conditions, from which they are protected when properly cared for. I am, however, happy to state that greater success has followed the dispatch to Queensland of Liberian coffee seed packed in damp moss, and that plants have been now successfully raised in the colony.

"I may remark as a necessary caution to persons who wish to procure seed of the Liberian coffee from England, that it is most essential to have it packed in small parcels and in damp moss. It germinates freely after the voyage to this country from Liberia, but a second transit has been proved by repeated experience to be fatal to it unless kept in a damp state.

"The following extracts from the letters of correspondents, showing that the Liberian coffee is susceptible of becoming established in widely distant countries, will be read with interest.

"Mr. Gammie writes to me from Darjeeling:—'I have given a few Liberian coffee plants to tea planters in the Sikkim Terai and Bhotan Doars, to see how they will succeed in those parts. If they get through this winter, which is doubtful, there should be good hopes of success. Hitherto they have grown most vigorously. Those in the Doars are described as being four feet in height, and with enormous leaves. The common coffee planted the same time is not a quarter the height. I have also planted a few in our warmest valleys, but have not much hope of their getting through the winter, as the thermometer falls as low as 45° some nights. With us the common coffee grows and fruits splendidly up to about 3,000 feet, but it is quite neglected by tea-planters. If the red-spider continues to be the serious pest among

the tea-bushes it has been this year the planters will probably turn their attention to the cultivation of coffee.'

"Dr. Thwaites writes to me from Ceylon:—'Our oldest Liberian coffee trees are giving us a little crop of berries for sowing, so we shall be able to distribute plenty in moderate quantity amongst the native cultivators before very long.'

"Mr. Murton writes to me from Singapore:—'Some plants (about 40) of Liberian coffee that I sent to H.B.M.'s Resident at Laroot about 12 months since are giving great satisfaction as far as growth is concerned. No disease has attacked them as yet.'

"Colonel Benson, in a communication to the Agri-Horticultural Society of Madras, sums up the result of the trials of plants supplied to the government of that Presidency from Kew somewhat adversely:—'A proposition has been made to introduce the Liberian coffee into the Presidency town of Madras, the climate being suitable to the habits of the plants. In my opinion the natural habitation for the plant would be the climate of Burma or the Western Coast. The plant has not made a favourable impression on and in the estates in the neighbourhood of the Neilgherry-hills. Its general appearance and characteristics are certainly not indicative of its being a heavy fruit-bearer, but the contrary, of a strong tendency to run to leaf and foliage. Perhaps its large size and corresponding increased bearing with space, and its larger berries, may more than compensate for a less prolific crop; or perhaps its appearance cannot be taken as a true criterion of its fruit-yielding powers.'

"Dr. Imray writes to me from Dominica at the close of the year:—'The fruit on the Liberian coffee comes to maturity very slowly, but I do not imagine more so than in its own habitat, for the conditions as to temperature, moisture, and elevation are almost the same, the height, it is true, being something greater, between two and three hundred feet above the level of the sea, but that makes only an average difference of 2° Fahrenheit. The berries of *arabica*, when they begin to redden, soon ripen, and become soft, and quickly drop from the tree, but I find that the fruit of *liberica* reddens very slowly, and the berries remain hard and are firmly fixed to the branches by short stout peduncles. It is now six weeks or two months since this reddening began to appear on the fruit of my trees, but the berries are still hard. I have gathered some of them, and on removing the pericarp, which is thick, hard, and leathery in structure (at present), I find the seed full and apparently perfect. Meanwhile the trees are loaded with blossom, some of the flowers have already opened and dropped, and the small fruit of next year's crop begins to appear.'

"Mr. Thomson, superintendent of the Jamaica Botanic-gardens, reports:—'The most promising feature in connexion with its introduction is its cultural adaptation to the conditions of climate existing at low altitudes. In Jamaica, the common coffee plant is the most accommodating of all our cultivated products, inasmuch as it is cultivated at all heights, from the sea level up to 5,000 feet. Under 2,000 feet the quality of the produce decreases in value as it approaches the level of the sea. . . . . As the peasantry, who are now the largest producers of coffee in the island, almost exclusively cultivate their coffee under 2,000 feet, and as the cultivation of the plant is being largely increased by them during recent years, in which time they have planted several thousand acres, the acquisition of a species of coffee, especially adapted to the climate of the lowlands, is a matter of great importance.'

"Mr. Thomson further adds that some 30 plants were distributed among coffee planters. 'These were planted in a variety of altitudes, and it has been practically demonstrated that those growing at the lower elevations have attained the greatest success. It is further interesting to note that one of the plants, only a little over a year planted out, has already fruited in the parish of St Ann, and at a height of above 1,000 feet above the sea.'"

Regarding the diseases to which the coffee is so liable, it seems that the *Cemiostoma coffeellum*, the insect which causes such devastation in Dominica, ravages the plants also in Venezuela, so that the mischievous little creatures has now been ascertained to be more or less distributed through the Leeward and Windward Islands (Puerto Rico, Dominica, and Martinique) and all the Atlantic coffee-growing districts of South America. On this point the Director says:—

"The ravages of the *Cemiostoma* over the greater part of this immense area date only within the last twenty-five years. In Dominica, Dr. Imray informed me that he was not without hopes that by care and attention the mischief caused by it might be gradually overcome, but the following extract from a more recent communication will show how extremely difficult it is to make any progress against it, and how important it will prove if the apparent immunity of the Liberian coffee from its attacks should continue to be verified.

"Dr. Imray writes:—'My coffee trees (of the country) suffered frightfully last season from the *Cemiostoma*, the small crop that was coming on upon many of the trees was all but destroyed. They begin to throw out leaves again, but I almost despair of finding any means of destroying the insect, where the circumstances and conditions are favourable for its propagation and existence. The problem is to discover the converse of this proposition, and I think I have made one step in that direction; it is, that the coffee trees should be cultivated almost, if not altogether, in the shade of trees, with no underwood or bush, as we say here. The coffee trees should scarcely see the sun. In a locality that is continuously cool and moist, and perfectly shaded by the foliage of large trees, they thrive best, and show very little appearance of the blight. The inference is that those conditions are adverse to the existence of the insect. From such inquiries as I have made, the coffee produced in this country, and it is not inconsiderable in quantity, is furnished by trees growing as above described. I intend to continue the experiment by planting some land cleared of low brushwood, and leaving the large trees standing. From the experience of fully two years now, I do not think that in this island the *Coffea arabica* can be successfully grown in the open, but we have now the Liberian to fall back upon.'

"With respect to the immunity of the Liberian coffee from the attacks of the *Cemiostoma*, Dr. Imray writes:—'That the Liberian coffee is impervious to the attacks of the 'white fly,' I consider a settled point. My Liberian trees have been now growing for over two years, nearly three, among the country coffee trees covered with the blight, and thus continuously exposed to the attacks of the insect, but not a leaf has been touched, indeed the destruction of one leaf by the fly would of course amount to the destruction of, or at least an attack upon all, but, clearly, this species of coffee is safe from the attacks of the *Cemiostoma coffeellum*. Such being the case, I have abandoned all further experiments on *arabica*, as being simply a waste of time and money.'"

From Dr. Kirk, the British Consul at Zanzibar, specimens have been received of the larva of what is probably a longicorn beetle, which bores the stems of the coffee plants through their entire length, and so great is the damage done, that a garden of trees is cleared in a few months; Dr. Kirk further adds, that the Liberian coffee, as grown at Zanzibar, is liable to attack from a large mole cricket, that cuts off the shoots with its jaws as with a pair of scissors.

In Queensland, the sugar-cane appears to be peculiarly liable to disease from various causes; the principal one, known as "rust," would seem to be traceable to the attack of an acarus which infests the young shoots of the cane in large numbers. The sugar-cane being grown from joints, the acarus would be easily communicated

from one crop to another. Dr. Bancroft finds that steeping the joints in milk of lime destroys the acarus, and probably a mixture of two to four ounces of fluid carbolic acid to a gallon of water would be still more effective. Another insect pest is described as having been received from the Albert River, Queensland. This, which is a species of coccus, hides itself between the sheathes of the plant. It is said to be as large as the seed of a *Sorghum*, of a flesh colour, and covered with a waxy powder. These insects were found on some plants grown from joints newly imported from Singapore, and are described as being probably indentical with the *pou blanc* which causes much destruction in the cane-fields of Mauritius. Two species, however, cause the mischief, and are known under the same collective name. The two species referred to are *Pulvinaria gasteralpha* and *Icerya sacchari*. The Queensland species, it is said, may be identical with one of these, or it may possibly be a third or distinct species. M. E. Icery, who studied the insect in Mauritius, remarks on their extreme tenacity of life, but states that he found by washing the canes with alcohol the insects were at once killed, and further recommends a solution formed by boiling a mixture of sulphur and lime in water. A third insect, injurious to the Queensland sugar-canes, is reported has having made its appearance among the roots of some canes received from Java. Little, however, seems as yet to be known about this pest.

Regarding the cultivation of the tea plant in Jamaica, it is satisfactory to find that 800 plants sent to the island in 1869 "are flourishing and seeding freely." If such is the case there seems no reason why tea should not become extensively cultivated in Jamaica; indeed, it is surprising that it should not have been more looked after before now. On the subject of substitutes for tea and coffee, four different products are enumerated, the first, the leaves of *Vaccinium arctostaphylos*, a shrub abundant on the Bithynian Olympus, where they are largely collected, dried, and slowly baked. These leaves have, it appears, become within the last few years a regular article of commerce in the country, and are sold at from 30 to 60 piastres the oke of $2\frac{3}{4}$ pounds. The second is the *Thé arabe*, of Algeria, which is, perhaps, more valued for its reputed medicinal properties than for use as a beverage. This tea is furnished by two species of *Paronychia*, *P. argenta* and *P. nivea*. The term *Thé arabe* is said also to be applied to infusions made from other plants, such as *Globularia alypum*, *Cistus albidus*, and *Aloysia citriodora*. The two substitutes for coffee are, first, the berries of *Coprosma baueriana*, a shrub of New Zealand, but frequently grown in English gardens, and, secondly, the seeds of *Cassia occidentalis*, a leguminous plant of Western Africa. They are known under the name of Fedegozo seeds, or negro coffee. Though no opinion is expressed in the report as to the probability of any of these substitutes becoming articles of commerce in this country, it seems, from their nature, however, very problematical.

India-rubber, or caoutchouc, as is well known, is derived from several distinct plants. The prospect of extending the resources from whence this valuable product can be obtained has occupied considerable attention. The Director, while deploring the loss of a large proportion of the young plants of the Para rubber (*Hevea brasiliensis*), brought to Kew by a certain collector, reports that from the same source seeds and plants of the Ceará rubber have been obtained, and a considerable stock successfully raised. Para rubber plants have been transmitted to Calcutta for distribution to Assam and Burma, where, it seems, they are now doing well. Favourable reports have also been received from Singapore, where it is said that, judging from the progress the plants have made, the climate is evidently suited for their growth. From Ceylon, Dr. Thwaites, of the Botanic-garden, Peradeniya, writes:—"We are now getting *Hevea* and *Castilloa* into our new garden [at a lower elevation and with a more tropical climate than Peradeniya], and we have fine healthy plants grown in bamboo pots to put in. Some of both kinds planted out here in the open ground are doing very well. We have as yet raised only one young plant of the Ceará rubber, but this looks healthy, and I hope more will come up from the seed sent me from the India-office." At a later period Dr. Thwaites further reports to Sir Joseph Hooker, as follows:—

"You will be glad to hear that I have been able to inform the Indian Government that the india-rubber plants under my care here are getting on satisfactorily, and that in due time we shall be able to furnish supplies for Burma, &c. We now find that cuttings of *Hevea* strike readily, as well as those of *Castilloa*, and there cannot be a doubt about the Ceará plant doing so. At present, the number of cuttings we get is not great; but, as the plants become more branched, we shall get many more. All the kinds are doing well, both in this (Peradeniya) and in our own tropical garden nearer sea level." In Jamaica, also, the plants of *Hevea* are doing well. The propagation of the Central American rubber plant (*Castilloa elastica*) is still being proceeded with at Kew, and during the past year plants of this species were sent to Liberia, Mauritius, Singapore, and Ceylon. The Ceará rubber, owing to its totally different habit from that of the other two species, will, it is thought, prove to be best fitted for cultivation in Bengal, and the drier parts of India.

Regarding new sources of india-rubber, reference is made to a creeping Burmese plant, the *Chavannesia esculenta*, which was first noticed so long back as 1860, and again made the subject of a pamphlet published in India in 1874. The plant is there stated to be one "for whose extermination in the teak tracts an annual budget provision is made." From Fiji samples of rubber were received at Kew, which were reported as "a strong, elastic, pure rubber, of the same character as the higher grades of African rubber." This rubber would seem to be the produce of a plant closely allied to *Tabernæmontana pacifica* or from *Alstonia plumosa*, both of which appear to yield caoutchouc in Fiji, and both of which belong to the same natural order Apocynaceæ. Regarding the rubber-producing plants of the east and west coasts of Africa, which are referred to as species of *Landolphia*, also belonging to the same natural family as the preceding, the Director reports that "being climbing plants which ascend lofty trees, they could not be grown like other rubber-producing trees in independent plantations. But they would doubtless flourish in the jungles of any tropical country.

"Mr. Christy, however, believes that they might be grown in a systematic manner, and that the plantations would begin to yield when three years old, while Para and other rubber-producing trees would not yield for a much longer time.

"The plants could be grown around existing trees, and thus trouble, time, and expense be saved.

"By the system of growing them in plantations, and cutting down the young shoots to the ground every year, the stems could be taken to the rolling mill, and the crushed mass digested with bisulphide of carbon, in which the rubber is soluble, but which does not dissolve the gum and resinous matters contained in the plant, and which if left in the rubber would injure its quality.

"In Western Africa the rubber is mostly collected in a very slovenly and wretched manner. According to the late Dr. Welwitsch the natives, having cut the vine, simply allow the juice to trickle down the arm, coagulating as it flows. They proceed from tree to tree, and when the arm is covered they peel off the caoutchouc, rolling it back from the elbow to the hand.

"As far as West Africa is concerned, and probably the remark will eventually be equally true in the case of East Africa, the collection of rubber will lead to the destruction of the plants producing it, at any rate in accessible districts.

"Mr. Sketchley informs me" the Director proceeds to say, "that the natives, rather than take any extra trouble, ruthlessly destroy every vine for the sake of obtaining a single supply of the elastic juice. The result is that vast as is the known area over which the rubber-tree is found, the natives, who alone are the producers, have to penetrate deeper and deeper into the forests for each year's supply."

A letter from Dr. Kirk, H.M. Consul-General at Zanzibar says:—"The district called Mungao extends from lat. 9° 25′ to Delgado in lat. 10° 41′. This last year yielded £90,000 worth of india-rubber—an industry that has been created in the last two years by my representations. This year the yield will be more, and other places are now collecting it. Thus Kilwa and Mombasa will this year probably double the supply, which I anticipate will reach in value not less than £180,000 worth of india-rubber. East Africa to the south, that is from Delgado Bay to the Zambesi, is producing it as well. I must try to get the plant introduced into India, for the quality is excellent, and if grown in the coast jungles would be an addition to the sources of wealth."

Efforts have been made to obtain these valuable plants at Kew, but at present without success.

The extensive cultivation and manufacture of tobacco is a point of very great commercial interest, and has occupied the attention of planters in different parts of the world for a considerable time, it is therefore satisfactory to learn from the Kew report, that it is at length being seriously attended to in English colonies, and that tobacco seed of the best kinds has been produced and distributed from Kew. With regard to its cultivation in the Bahamas, the Governor writes thus under date of October 22nd last:—

"The cultivation of tobacco in the Bahamas is rapidly extending, and there are at least three stores in the place at which cigars from tobacco grown in the islands are made. The Agricultural Board has secured the services of a Cuban as inspector of tobacco cultivation. He is very sanguine as to the success of the experiment, and is confident that tobacco as good as that grown in Havana can be raised in the Bahamas. He has given instruction in curing and fermenting tobacco, and expects to export to America several thousand pounds of this season's leaf tobacco. Tobacco has not yet entered into our exports, but I am convinced it will do so on a large scale.

"With regard to the Shiraz seed you sent me, I have to report that every seed germinated, and that I am assured by good judges that, though not well cured, this tobacco is of very fine quality, and that its cultivation will amply repay any industrious agriculturist."

The next important country where tobacco promises to become a large commercial product is Jamacia, from which island the Governor thus writes:—"You will see from the statements of exports that from nothing before 1871 the values of tobacco and cigars sent out amounted to nearly £5,000 in 1876-77. But this represents but a small portion of the production, because our own consumption is now supplied from domestic sources. I am a smoker myself in moderation, and I don't wish for better cigars than I get here. The manufacture I think particularly good."

The following extracts from a memorandum furnished to the Governor by a gentleman interested in tobacco cultivation in Jamaica will further prove the capabilities of the island for its cultivation:—

"The results obtained by the different planters are, as is well known and admitted, even by Cubans not interested in this undertaking, of the greatest importance, and have proved beyond a doubt that our produce is one worthy of attention, and one which will stand competition with that of other countries, the reputation of which has been established long before. As the result of my journey to England and Germany last year, I may mention that in the Hamburg market, the most considerable in the world for tobacco, I found that our produce stood next in rank to the Havana tobacco, to which it was pronounced inferior, but superior to all other kinds, even not excepted those other parts of Cuba, such as St. Jago, Manzanillo, Yara, &c., which furnish such a very considerable quantity to the consumption at home."

. . . .

"As for the outlet and sale of our produce every one interested has found that the German markets, especially that of Hamburg, has given it the best reception and greatest encouragement. Our tobacco is readily sold there, and, though the first hands may buy it as Jamaica, the consumer in most cases will not know better than that it is Cuban or even Havana."

. . . .

"Jamaica has shown that it can produce a tobacco which has proved itself worthy of being introduced as a new article of industry, and, considering the short time that has elapsed since it was first established as such, we have gained a by no means small success. Whatever faults there may exist about the different branches, there are none which time cannot overcome."

Besides the Bahamas and Jamaica, the Fiji Islands appear well adapted for the cultivation of tobacco, judging from a report made of a sample sent to Kew, as well as from samples that have recently appeared in the London market.

Under the head of "Paper Materials," the question of the utilisation of the bamboo, a subject which has been discussed in this *Journal*, comes again to the front. Several other substances are mentioned as having been brought to notice, or even tried, but none of them seem to have given satisfactory results. The Bamia cotton, about which so much was said in the public press about two years since, and recommended for extended cultivation on account of its much taller growth, unbranching habit, and greater freedom in producing its pods, proves to be only a variety of the ordinary American cotton, *Gossypium barbadense*, and to approach nearly the sea-island variety.

Several other products of minor importance are treated of in the Kew report, but those here enumerated are the principal points.

GENERAL NOTES.

The Turners' Company's Prizes.—The Company of Turners propose to give this year their silver medal, the Freedom of the Company, and other prizes, to any workman, whether master, journeyman, or apprentice in the trade in England, who may send in the best specimen of hand-turning in wood, diamond-cutting and polishing, and throwing and turning in pottery. The competition in wood includes turning in both hard and soft wood. The work must be all hand-turning, produced in the lathe "without special rest or tool apparatus," and the carving must be the work of the exhibitor. The competition in pottery includes terra cotta, stoneware, earthenware, and porcelain. In the diamond-cutting and polishing competition, the Baroness Burdett-Coutts, who is a member of the Company, has placed at the disposal of the Court the sum of £20, to be distributed in this class among the competitors. Past-Master C. Christopherson has placed at the disposal of the Company a sum of £10 to be awarded as a prize for the best specimen of amateur work in ornamental turning, in either ivory or hard wood, executed during the period of competition. Any lathe apparatus may be used.

Pollution of the Thames by Sewage.—The *Daily News* of the 27th July, giving a report of the meeting of the Metropolitan Board of Works, states that the Duke of Sutherland, on behalf of Scott's Sewage Company, has requested the Board of Works to inquire if Scott's system, successfully carried out at Burnley, might not be applied to the Metropolitan sewage with advantage to health and economy. The Board referred the letter to a committee.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,343. Vol. XXVI.

FRIDAY, AUGUST 16, 1878.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

NATIONAL WATER SUPPLY.
HEALTH AND SEWAGE OF TOWNS.

The Reports of the Congresses on the above subjects have been published in pamphlet form, and each report can be obtained at the Society's House, price 2s.

GROSVENOR HOUSE.

The Duke of Westminster is desirous that designers, artisans, and the like, employed in any branch of Art applied to productive industry, should have the opportunity of inspecting Grosvenor House, with its Works of Art, daily, including Sundays, during the months of August and September, 1878, from 2 p.m. to 6 p.m. He regrets that, for want of room, he cannot extend the admission beyond the persons specified.

A number of tickets of admission have been placed in the hands of the Secretary of the Society, for distribution among persons answering to the above description.

Such persons can obtain tickets on application at the Society's house, by bringing with them a paper containing their names, addresses, and occupations.

Each ticket admits a party of four.

There will be no admission on wet afternoons.

CANTOR LECTURES.

THE APPLICATION OF PHOTOGRAPHY TO THE PRODUCTION OF PRINTING SURFACES AND PICTURES IN PIGMENT.

By Thomas Bolas, Esq., F.C.S.

Lecture V.

Collotypic Printing.

You have already seen how extended is the use of bichromated gelatine in photo-mechanical printing processes, and we now have to study a method in which the gelatine itself is used as a printing surface.

The bare principles of collotypic printing are as follows:—A plate of glass or metal is coated with a uniform layer of bichromated gelatine, and this is exposed to light under a negative. Certain parts become insoluble by the action of light, others remain soluble and capable of absorbing water. The plate is damped, and a roller, charged with fatty ink, is passed over it. Those parts which received the water refuse the ink; and a piece of paper being laid on and pressure applied, the ink sets off on the paper, forming a print. But more than this is true, as we have an infinite number of grades between the two extremes of water-taking parts, and of ink-taking parts; those parts which had a slight exposure to light being capable of receiving both ink and water, the proportion in which each is received depending on the extent to which the part has been acted on by light. Here is a damp collotype plate; I hold it up to the light, and those who are near can see a very feeble image. I now pass the inking roller over it a few times, and the fatty ink adheres to those parts which have been exposed to light, the amount of ink being proportionate to the extent to which the light has acted; so that a picture is built up with all its gradations of light and shade. I hold up the inked plate before the light, and you see the image distinctly. I will now hand round the inked plate, together with a similar, but uninked plate. Here is one more plate, which I take from this dish of water; this I will ink, and take an impression from it on paper. Here they are, you see. If you hand them round, you can compare the plate with the proof printed from it.

The first step in preparing the collotypic plate is to take two pieces of plate-glass, such as I have here, to put some water and flour emery on one of them, then to grind them together until the rubbing surfaces are uniformly de-polished. It is not worth while for me to go on grinding these until they are finished, but here are some finished ones which you can examine. When the plates have been sufficiently ground, they must be well rinsed, and reared up against a shelf to dry. The next thing is to prepare a mixture of seven parts of albumen, three parts of commercial water-glass solution, and ten parts of water. This mixture being made, it is churned to a froth by one of these American egg beaters. You see it only takes about two minutes to convert the whole into a froth. I now pour this froth on a paper filter, and as it breaks up it runs through. This solution is now ready to pour on the plates, and you see that it runs easily over. I now let it drain off at one corner, and allow the plate to dry in an inclined position. When dry, the plate is well rinsed in water, in order to remove all soluble matter, and is again reared up to dry. In this state the plate is covered with an extremely thin whitish film, which causes adhesion between the plate and the gelatine coating which is next applied. The sensitive gelatinous mixture is prepared by dissolving six parts of gelatine in 48 parts of water, and adding one part of ammonium bichromate, and 48 parts of alcohol. The mixture is then strained through fine muslin, and is ready for use.

Here is a metal hot plate, made double, and in the interspace water is kept boiling. Three

levelling screws support one of the prepared glass plates, about an inch from the surface of the metal hot plate. The glass plate usually reaches a temperature of about 50° C. under these circumstances, and when this is the case, and the plate is quite level, all is ready for coating it with the sensitive gelatine. I now pour on the middle of the plate as much of the sensitive mixture as it will conveniently hold, and you see that it runs well over the plate, even up to the corners. I now lift up the plate quickly, drain off the excess of gelatinous mixture, give the plate a rocking motion, and put it back on the levelling screws in its old position. In about ten minutes it will be dry and ready for exposure in the printing frame, and this exposure is about equal to that which would be required to make a silver print from the same negative; but a plate which has been dried quickly requires a longer exposure than one which has been dried slowly.

Mr. Debus is now holding a dried plate against the lime light, and you merely see an even yellow tint, arising from the uniform film of bichromated gelatine. He will now hold up a similar plate which has been exposed under a negative, and you see a faint brownish image, showing all details and shades of the original. After having printed the plate under the negative, the next step is to soak the plate in cold water, in order to remove the free bichromate; and during this soaking the image becomes much fainter, as you will see when I hold this soaked plate before the lime light. During this soaking in water another change, and a remarkable one, takes place; all the exposed parts of the plate become puckered up into a multitude of little folds, which wind about in a very peculiar manner. These folds may be traced almost all over the picture, their depth being greatest on those parts which have been most exposed—at least up to a certain limit, beyond which increased exposure tends to destroy the folds. The pitch of these folds may vary from about fifty to three hundred to a linear inch, and this pitch varies according to the treatment of the plate, the kind of gelatine used, the condition of the bichromate, the length of time which the sensitive mixture is kept before use, the rapidity of drying, and other circumstances. This puckering, reticulation, or grain has much to do with the printing qualities of the plate, one with a coarse grain being easier to print from than one with a fine grain, but the results are, in general, not so good. When the plate has been soaked in water sufficiently long to remove the excess of bichromate and to develop the grain, it is taken out and allowed to dry spontaneously. The dry plate may then be kept without injury for several days, or weeks, or even months. It should be kept in a dry cool room, and, as a rule, ought not to be put away in a brightly lighted place.

We now pass on to the inking of the plate and its treatment in the press. Before use the plate should be soaked in water, in order to saturate the soluble portions of the gelatine with this fluid, and generally five or ten minutes is sufficient for this purpose. It is usual to employ the ordinary lithographic roller, and ordinary lithographic inks, for collotypic printing, and when a lithographic roller is in really first-rate condition it answers admirably; but a new lithographic roller can only be got into a sufficiently good condition by daily exercise for about a month, and the least carelessness, the drying of ink on it, or a cessation of work for a few days, will degrade it from the state of a roller suitable for collotypic work to that of an ordinary roller suitable for lithography.

Here is a form of roller which I have devised, and have found to answer admirably, as it is always ready for use. It consists of an outer cylinder of red india-rubber, made smooth on the outside by means of fine glass paper; inside this is a thickness of about three-quarters of an inch of ordinary typographic roller composition (glue and treacle), and inside all a wooden core, provided with handles. To make this kind of roller, I put the india-rubber cylinder inside this brass mould, place the core in position, and pour in a little of this glue-and-treacle composition—just enough to seal the joint at the bottom—and when this has set I will fill the space with the glue-and-treacle mixture. When a roller of this kind is done with, the ink can be cleaned off by means of a rag moistened with a little oil of turpentine, care being taken not to use too much. The roller is then ready to be put away, and can be brought into use again at a moment's notice.

The labour of mixing stiff inks and colours, and of getting an even film on the inking slab, is considerable; but I have found that the following plan obviates all difficulty on this score. The ink is mixed up with oil of turpentine to the consistency of cream, and the colour may be modified by the addition of the artists' oil colours which are sold in tubes. In this way a thorough mixing of the colours is ensured, and when it is intended to use a portion, a piece of muslin is tied over the mouth of the bottle containing the colour, the bottle is then inverted, and the muslin-covered neck is rubbed over the inking slab. The ink thus filtered out is spread evenly by means of an ordinary typographic ink roller, and is then allowed to remain a few minutes, in order that the turpentine may evaporate. Thus is obtained a layer of ink, free from lumps, well mixed, and evenly spread. The collotypic plate, being now taken from the water, is laid on the bed of the press, this having been previously covered with a sheet of white paper, and is gently wiped with a soft piece of muslin. The inking roller being charged with ink from the slab, is gently rolled backwards and forwards, as I am now rolling, it being borne in mind that a slow rolling with heavy pressure tends to put much ink on the plate, and quick rolling with light pressure tends to take off an excess of ink. It is advisable to be provided with two inks, one rather thinner than the other, as the half tones sometimes require a thin ink to bring them fairly out. To make this thin ink, a little of the very fluid lithographic varnish (known as tint varnish or S.H. varnish) is added to the mixture of turpentine and ink. The kind of press best adapted for collotypic printing is the roller lithographic press, like those commonly used in France and Italy—a Waterloo's autographic press is very well adapted for the work—but the scraper press does not answer so well. You see that the press I am using consists merely of two rollers, with the tympan and bed riding between them.

The plate having been inked, and the paper laid

on, a moist sponge is passed over the back of it. I then put on a few thicknesses of blotting paper and a sheet of india-rubber an eighth of an inch thick, shut down the tympan, and pass through the press. Here, then, is the result.

Any kind of paper may be used for collotypic printing, but if it be desired to imitate silver prints, a thin and rather soft enamel paper must be used, and the prints must be varnished with a varnish prepared by dissolving two parts of white shellac and one part of mastic in a convenient quantity of methylated spirit. The strength of the solution will depend on the effect required, and it is scarcely necessary to say that the varnish must not be allowed to chill. Here is a print; I will varnish one half of it, and when dry, you can compare the two sides.

The process which I have demonstrated to you is practically that of Professor Husnik, as set forth his invaluable work on the subject,* and if I were to give you the leading features of the various collotypic processes, I should occupy several hours in doing it. The characteristic feature of the Albertype process consists in covering the glass plate with a film composed of gelatine, albumen, and potassium bichromate, and exposing this to light through the plate of glass, so as to make that part in immediate contact with the glass insoluble, washing off the soluble portion in warm water, so as to leave a very thin film of insoluble gelatine, capable of serving as a bond between the glass and the actual printing film, which is now applied.

Mr. J. R. Sawyer, of the Autotype Company, has elaborated a process by which he has produced magnificent results, some of which you may see hanging up all round the room. You will see among these representatives of almost all classes of photographic work—ancient manuscripts, coins, architecture, landscapes, engineering works, and book illustrations. Directly opposite to me is an exceedingly fine collotypic print of Norwich Cathedral, and this is from one of Mr. Sawyer's own negatives. You will also notice a series of prints representing the great public engineering works of France, which are now being printed by the Autotype Company, under the direction of Mr. Sawyer. The production of this series, regularly and in large numbers, proves the thorough practicability of the collotype process when in careful hands.

You see before you some admirable specimens of collotypic printing, by Messrs. Braun, of Dornach, Messrs. Strumper and Co., of Hamburg, and Messrs. Wright and Co., of London.

The next great step in collotypic printing is the application of steam machinery to the process; the difficulties of wiping the plate, inking, and taking off the paper, by machinery, are considerable, but these difficulties are being gradually overcome.

The export of gloves from Denmark has risen in ten years from 12 000 francs in value to 1,200,000 francs (£48,000). The manufacture of gloves in the town of Luxembourg also gives employment to about 2,000 work-people, who produce annually nearly 800,000 pairs, valued at £100,000.

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* Das Gesammtgebiet des Lichtdrucks. J. Husnik. 3 Mark. Hartleben, Leipzig.

MISCELLANEOUS.

TREATMENT AND DISPOSAL OF SEWAGE IN CHINA.

Her Majesty's Secretary of State for Foreign Affairs has been good enough to obtain, at the request of the Council, the following reports on the treatment and disposal of sewage in China:—

The Treatment and Disposal of Sewage in Peking.

Peking is fairly well supplied by water. In addition to the numerous surface wells within the walls of the city, the water of which is hard and charged, especially during the rainy season, with organic impurities, which percolate the porous sandy soil; there is an abundant supply of purer and softer water, derived from the springs and lakes of the vicinity of the summer palaces, situated at the foot of the western hills, some eight miles distant. A wide stream runs to the north-west angle of the city wall, where it opens out into a large reservoir, in which the water is confined by dams, the surplus supplying the city moat. From this reservoir the water is conducted by a canal which, after passing under the north wall, expands into several large lakes, from which proceed two canals which traverse the Tartar city. The Chinese city is similarly supplied by a small river, which flows from the Nan Haitzur, the vast southern hunting park, and ends in the moat. The water from these sources, after traversing the two cities, ultimately finds its way into the Tungchow Canal.

The sewers intersect the city in a rectangular network, and open into the canals. The wide parallel streets have a large sewer on either side, into which open the smaller sewers from the lanes. The main sewers are square in section, of diameter sufficient to allow a man to crawl through them, and are constructed of large bricks, and covered with a layer of stone slabs. They are intended principally to carry off the flood of rain-water which inundates the city in July and August. This elaborate system, however, is all but useless, having long since fallen into ruin from decay and neglect. Some of the sewers project high above the level of the roadway, gradually worn down by traffic. All are chronically choked with animal and vegetable *débris.* It is the common practice of the inhabitants to remove one of the flagstones in front of their houses, and to throw in all the refuse, solid and fluid, so that the sewer becomes merely a focus of putrefaction. The putrid contents overflow into the streets after rain, and in dry weather are tapped for the purpose of watering the roads. In short, the sewers in their present condition are not only useless, but absolutely prejudicial to the public health.

The only detail of sanitary work which is at all efficiently performed is the removal of fæcal matters. The fluid excreta are either poured into the roadway or open sewer, or scattered over the street at sunset to lay the dust, but the solid excreta are most carefully collected, as in all other parts of China, for use as manure. They are removed entirely by the dry method. There are no cesspools in the houses, only a shallow hole lined with bricks, which is emptied daily by the scavenger. This is a regular business and means of livelihood in Chinese cities, and the man with a large wooden tub suspended on his back by means of a wide hoop passing over the shoulder, and a long-handled iron scoop in his hand, is a well-known figure in the streets. He does his work, as a rule, gratuitously, passing from house to house till his tub is full, when he carries it to dispose of

the contents at one of the depots or manufactories. Another man wends his way along the public highway, where he also is able to pick up a fair livelihood, for the common Chinaman never scruples to halt by the wayside, even in broad daylight, and in full view of passersby. The scavenger often digs holes in the ground of the more retired corners within his circuit, for the convenience of the wayfarer and profit of himself.

The matters collected in this way are carried to one of the depots, whence they are conveyed outside the city in wheelbarrows, with a central wheel of large diameter, and on each side of the wheel a long coarse wicker basket, of the estimated capacity of two cwt. The wheelbarrow is driven by one man, who supports it with a yoke over his shoulders, and is assisted by one or more other men dragging with a rope in front. These baskets are quite open at the top and, being conveyed through the streets at all hours of the day, they are an insufferable nuisance. Within the walls of the city itself, moreover, there are not a few manufactories of manure, and, in fact, any large vacant piece of ground is usually utilised for this purpose. The excreta are first emptied into large holes dug in the ground, then spread over the surface in a layer about an inch thick, and constantly turned over with a spade until they become thoroughly dry. This process takes three or four days, the ground being dry and sandy, and the air remarkably free from moisture during ten months of the year. The manure, when dry, is piled into heaps, and sold retail by the small basket. A ton of this *poudrette* is estimated to sell for about sixteen shillings of our currency, which is the equivalent of a month's wages of a labouring man in this part of China.

It is a principle in native husbandry to apply manure to the plant rather than to the soil. The *poudrette* is sown with the seed or supplied to the root of the growing vegetable before irrigation.

In connection with this subject a condensed note on the comparative prevalence of certain diseases may be appended. Entozoa are very common in China. The natives scrupulously avoid drinking unboiled water, but, on the other hand, they are fond of raw and half-cooked fruit and vegetables. An unusually large proportion of children come to hospital suffering from the presence of lumbrici. Tœnia is also often met with, the result of the universal consumption of pork, which is, besides, not infrequently infested with trichina. The pigs are allowed to wander through the streets, and foreign residents are obliged to refrain from native pork. Of zymotic diseases dysentery and diarrhœa are prevalent, and especially dangerous after the rains, and appear to have direct relation with the amount of heat and moisture. Typhoid fever is a rare disease all over China, although typhus, diphtheria, scarlatina, &c., are rampant in the large cities. The rarity of typhoid may be directly due to the system of the removal of human excreta, preventing the contamination of water.

S. W. Bushell, B.Sc., M.D., Lond.
Univ. Scholar, Physician to
H.B.M. Legation.

Peking, 13th February, 1878.

Treatment of Sewage in Canton.

In all parts of the city of Canton there are public latrines erected, consisting of a number of compartments separated by a wooden partition. These are the property of the "Kai-foig," or street organisation, who, by the money derived from their rental, contrive to defray a considerable portion of the municipal expenses. The solid and liquid excreta collected separately from these receptacles, which are only used by men, are removed daily to the fields in baskets and buckets. The night-soil from private dwellings is carried away daily by women employed for the purpose, who empty and wash the utensils, and convey the matter to boats built specially for this object, by which it is taken into the agricultural districts, that from Canton going chiefly to the Tungkwan district. The solid excreta are usually partially dried before being used as manure, and are occasionally mixed with ashes. Liquid manure is very largely employed for watering vegetables. Every country village has on its outskirts a pool or tank, on the banks of which latrines are built, and into which the sewage flows. In the winter the liquid is drained off, and the solid deposit at the bottom, which is rich in fertilising matter, is dried and used as manure.

The sewers in the city of Canton are cleared out triennially by the authorities, and the deposit carried off to the fields. But besides this, the liquid black matter which collects is taken away from time to time, when considered sufficiently rich in fertilising matter to pay the cost of removal, by men who obtain access to the sewer by removing a stone from the pavement.

The foregoing is all the information I have been able to obtain upon the subject.

H. Hance,
H.M. Acting-Consul at Canton.

Canton, March 28th, 1878.

Treatment of Sewage in Foochow.

Sir,—In reply to your despatch, No. 1, of the 25th ultimo, on the subject of town sewage, I beg to offer the following information.

In the town and suburbs of Foochow there are drains under the main streets only, the side lanes being without; the scourings of the dyers and pulse makers, together with the waters and slops of dwellings and shops, compose a sewage of dark and rich consistency made up from the silting of the river tides which wash the drains. It is much sought after for the purpose of enriching ground set apart for rice cultivation in its natural state. There being none but public privies, human excrement is emptied into the street, and is fetched, in pails, from long distances in the country by gangs of men and women, and then cast into open pits, lined with chunam, until wanted for manure. When diluted with two-thirds of urine and water, the market gardeners sprinkle it over the cabbages. Millions of tubs of this description of manure are employed in this way, to quicken the growth of vegetables, potash being in a few instances added to the composition. No part of this valuable manure is lost in sewers, while the cost of its transport into the country must be enormous.

There is not much difference in the method of manuring in any of the provinces south of the Yellow River.

C. A. Sinclair,
H.M. Consul at Foochow.

Foochow, February 28th, 1878.

THE DISTRIBUTION OF AMMONIA.*

By Dr. R. Angus Smith, F.R.S., &c.

If organic matter is everywhere, ammonia is everywhere possible, and if that matter is decomposing, ammonia is everywhere. This is the general statement which this paper illustrates. It is now many years since it was observed by me that organic matter could be found on surfaces exposed to exhalations from human beings; but it is not till now that the full significance of the fact has shone on me, and the practical results that may be drawn from it in hygiene and meteorology. These results are the great extension of the idea that

* Paper read before the Manchester Literary and Philosophica Society.

ammonia may be an index of decayed matter; the idea itself has been used partly and to a large extent, as illustrated in my "Air and Rain." The facts now to be given enable us to claim for it a still more important place. The application seems to fit well the conditions already examined, and by this means currents from foul places have been readily found. This does not apply to the substances which may be called germs, whether it be possible to see them or not, because these are not bodies which have passed into the ammoniacal stage, although some of them may be passing; those, for example, which are purely chemical, and exert what we may call idiolytic action. This word may serve to mark this peculiar action, which was left by Liebig unnamed; he used the vague term invented by Berzelius, namely, catalytic. I have elsewhere recognised the two classes of germs, instead of any disputed one, without naming them.

It is now many years since Liebig first surprised me by saying that iron ores and aluminous earths were capable of taking up ammonia, and if they were breathed upon we were able even to smell that substance. He, much about the same time, made numerous experiments, in order to find the ammonia of the atmosphere, and to measure its amount in rain. The result for science was great, and Professor Way continued the inquiry for the Royal Agricultural Society. Dr. Gilbert, F.R.S., amongst his many labours in the department of agricultural science, has made this inquiry into ammonia of rain in still later times; but I shall not at present quote his results, as this paper does not intend to go fully into the subject, but rather to indicate its magnitude and importance. The first paper I ever read to this Society was on the ammonia found in peat: I was unable then to see the extent of the subject.

I shall give parts of the fuller paper without the long tables of results.

Ammonia must ever be one of the most interesting of chemical compounds. It comes from all living organisms, and is equally necessary to build them up. To do this, it must be wherever plants or animals grow or decay. As it is volatile, some of it is launched into the air on its escape from combination, and in the air it is always found. As it is soluble in water, it is found wherever we find water, on the surface of the earth or in the air, and probably in all natural waters, even the deepest and most purified. As a part of the atmosphere it touches all substances, and can be found on many; it is, in reality, universally on the surface of the earth, in the presence of men and animals, perhaps attached, more or less, to all objects, but especially to all found within human habitations, and, we might also add, with equal certainty, the habitations of all animals.

If you pick up a stone in a city, and wash off the matter on the surface, you will find the water to contain ammonia. If you wash a chair, or a table, or anything in a room, you will find ammonia in the washing; and if you wash your hands, you will find the same; and your paper, your pen, your table-cloth, and clothes, all show ammonia, and even the glass cover to an ornament has retained some on its surface. You will find it not to be a permanent part of the glass, because you require only to wash with pure water once or twice, and you will obtain a washing which contains no ammonia. It is only superficial.

This ammonia on the surface is partly the result of the decomposition of organic matter continually taking place, and adhering to everything in dwellings. The presence of organic matter is easily accounted for, but it is less easily detected than ammonia. It is probable that the chief cause of the presence of ammonia on surfaces in houses, and near habitations, is the direct decomposition of organic matter on the spot. If so, its presence, being more readily observed than organic matter itself, may be taken as a test, and the amount will be a measure of impurity. A room that has a smell indicating recent residence will, in a certain time, have its objects covered with organic matter, and this will be indicated by ammonia on the surface of objects. After some preliminary trials, seeing this remarkable constancy of comparative results and the beautiful gradations of amount, it occurred to me that the same substance must be found on all objects around us, whether in a town or not; I, therefore, went a mile from the outskirts of Manchester, and examined the objects on the way. Stones that not twenty hours before had been washed by rain showed ammonia. It is true that the rain of Manchester contains it also; but, considering that only a thin layer would be evaporated from these stones, it was remarkable that they indicated the existence of any. The surface of wood was examined—palings, railings, branches of tree, grass (not very green at the time), all showed ammonia in no very small quantities. It seemed as if the whole visible surface around had ammonia. I went into the house and examined the surfaces in rooms empty and inhabited, tables, chairs, ornaments, plates, glasses, and drawing-room ornaments. A (Parian) porcelain statuette, under a glass, showed some ammonia; a candlestick of the same material (but uncovered) showed much more; the back of a chair showed ammonia, when rubbed with a common duster, very little. It seemed clear that ammonia stuck to everything.

If, then, ammonia were everywhere, the conclusion seemed to be that it was not at all necessary to do as I had been doing, namely, wash the air so laboriously; it would be quite sufficient to suspend a piece of glass, and allow the ammonia to settle upon it. For this purpose small flasks were hung in various parts of the laboratory, and they were examined daily. The flasks would hold about six ounces of liquid, but they were empty, and the outer surface was washed with pure water by means of a spray bottle; it was done rapidly, and not above 20 c.c. (two-thirds of an ounce) of water was used. This was tested for ammonia at once with the Nessler solution. The second washing produced no appearance of ammonia, done immediately. Ammonia could be observed after an hour and a half's exposure, at any rate, but I do not know the shortest period. The results of the washings were as follows; they are the average of 34 experiments for some, and 17 for others; in all 238 experiments:—

	Height from floor.	Ammonia.	Height from floor.	Ammonia.
	ft. in.	M.gms.	ft. in.	M.gms.
Front laboratory	7 3	0·013	4 2	0·019
Second landing..	6 0	0·032		
Balance-room...	5 1	0·015	0 8	0·009
Firstlanding....	4 10	0·007		
Back laboratory.	4 5	0·010	0 6	0·010
Entrance lobby..	6 5	0·007		
Office..........	4 7	0·003		
Back yard......	4 8	0·036	0 7	0·042
Back closet......	2 3	0·105		
Midden.........	—	0·572		

The first three belonging to the working laboratory are not very regular, as we might suppose, but they never rise very high, nor do they sink to the lowest. The rest, except the second, keep a remarkable similarity, and the differences are very great. In the second there is a disturbance caused by sweeping the floors. On the other days it was requested that everything should be kept still. This of course brings in a practical difficulty, and limits the use of the test to cases where care can be used and thoughtful observation, since there are many ways by which dust may be made to interfere, even although the act of sweeping should not take place. The house experiments gave similar gradations.

The result seems to be that a piece of glass, of a de-

finite size, hung up in any place, will receive deposits of ammonia, or substances containing ammonia, in a short time; and by washing the ammonia off with pure water, and testing it with a Nessler solution, it may be seen whether there is too much or not. It is the simplest test for ammonia yet found. Its discoverer deserves great thanks. It must not be forgotten that we may have ammonia in very different conditions; it may be pure, or it may be connected with organic matter. This mode of inquiry is better suited as a negative test to show that ammonia is absent, than to show what is present. When ammonia is present there may be decomposing matter; when absent there is not. I am hoping to make this a ready popular test for air—a test for sewer-gases,* for overcrowding, for cleanliness of habitations, and even of furniture, as well as for smoke and all the sources of ammonia. Of course it must be used with consideration, and the conclusions must not be drawn by an ignorant person.

How far it may be used as a test of climate is a matter to be considered.

After this I made another series of trials with air, Nesslerising the washings at once, and not after laborious distillings, as in former cases; the results are very valuable, showing that we obtain comparative quantities in this way.

The amount of ammonia obtained in this ready way does not give exactly the same results as the more laborious methods which I have used, but it may be taken as the most convenient. It must be observed that the amount rises exactly where you might expect more organic matter to exist. The lowest is from Prince's-road, outside the town, and almost a half a mile from the extreme of the Manchester houses. The next is obtained from an empty yard behind my laboratory, but it is still pure because there was wind and rain; and any one who observes how unusually pleasant it is to breathe air even of a smoky town during wind and rain will not be surprised. I have not yet, however, had the purest air. I shall require to make a campaign on the moors, hills, and seas before I can give numbers for this. I have not even obtained the best given on land at a distance from manufactures. All this will be done in time.†

In my office the amount is larger than outside, but the air is not so bad as it is in front, and not so good as sometimes in the front where it is open. From the back of the laboratory, during fog, the ammonia was much higher, but during one day it was excessive, and a special examination of it was made in several streets. The highest amount was obtained at the front of the Cathedral, about midday, on the 8th of February, 1878, when the amount was 1·25, or 14½ times more than it had been found in Prince's-road, showing a considerable range:—

	M.grms. of ammonia per cubic metre of air.
Prince's-road	0·086
Open yard during rain	0·119 and 0·102
Front of laboratory	0·167 ordinary
Office	0·167
Front and back during fog	0·476
Close shut up room	0·413
Closet outside	0·800 to 0·900
Densest part of fog	1·25

The following shows the progress of cotton spinning in India during the past four years:—1874, 593,000 spindles, 114,000 bales of 390 lb.; 1875, 866,000 spindles, 170,000 bales; 1876, 1,124 000 spindles, 216,000 bales; 1877, 1,231,000 spindles, 237,000 bales.

* For sewage also to a larger extent than it has yet been used.

† Since the paper was read I examined trees and stones at Skelmorlie and Wemyss Bay, finding very little ammonia.

INDIAN TRADE ROUTES.

The handbook upon the Indian exhibits at the Paris Universal Exhibition contains an historical description of the commerce of that country, by Dr. Birdwood, which deserves particular attention at the present time. Commenting upon the geographical features of Asia and Europe, which seem to invite the natives to mutual intercourse, he observes that the renown of the riches of the trade in spices and other aromatics with the islands of the Eastern Archipelago was propagated all over Asia and Europe in the legends of the Land of Gold, and the geographical and other myths of fable and folk-lore are the vague, broken traditions of an immemorial trade, in its prehistoric beginnings, pursued along the shores of old romance. For centuries this commerce was carried on, not directly between one country and another, but through innumerable intermediate agencies, so that distant countries knew each other only by their productions, and the strange "travellers' tales," which grew in wonder as they were passed from mouth to mouth between the East and the West. The very name of India remained unknown among the natives of the Mediterranean sea for centuries after its costly perfumes had been in daily use in the service of the Jews' Tabernacle at Shiloh and Jerusalem, and earlier still for embalming the dead in Egypt.

The southern coast line of Europe and Asia is interrupted between the Mediterranean and Red Sea by the Isthmus of Suez, and as, from this point, the peninsula of Arabia extends for about 1,500 miles southwards into the Arabian sea, the Isthmus of Suez really presents the length and breadth of Arabia as an obstruction to the direct course of the trade between the Mediterranean and Indian Ocean. As it is twice as long from Suez to Aden as from the Mediteranean to the head of the Persian Gulf, the commercial advantages of the Red Sea route, even after the discovery of sailing to India by the monsoons, have always been nearly equalled by the comparative shortness of the route by the Persian Gulf and Euphrates Valley. From time immemorial these two lines have competed on almost equal terms for the commerce of India, and the competition between them is the true key to the history of the successive States and empires which rose and fell along their course; rose as they gained the trade of India; fell when they lost it. So great an obstruction was the Isthmus of Suez found to be, that the rulers of Egypt twice or thrice endeavoured to cut a canal between the Red Sea and the Nile; while, in the hope of avoiding the circumnavigation of Arabia, the daring attempt was successfully made to circumnavigate the continent of Africa itself.

So important are the positions in connection with the Red Sea and Persian Gulf routes, that not only was there always a rivalry between the nations on the Persian Gulf and those on the Red Sea, but it was a vital question among the latter whether the Indian trade should go by the Gulf of Akaba or the Gulf of Suez. The rivalry between Assyria and Egypt, and Assyria and Phœnicia, and between Jerusalem and Tyre on the one hand, and Jerusalem and Petra on the other, which finds such startling expression in the prophetic denunciations and lamentations of Isaiah, Jeremiah, and Ezekiel, had largely for its origin the competition for the monopoly, or at least a share, of the riches of the commerce of India and the Eastern Archipelago. The overwhelming vantage ground of the Semitic races, and particularly of the Arabians and Phœnicians (for the Jews were somewhat unfortunately placed between the Idumæans and the Phœnicians), was that, from the dawn of history, they were already in possession of all the lands separating the Mediterranean from the Red Sea, the Persian Gulf, and Indian Ocean. This gave them their start in the civilisation of the world. The

Phœnicians in the Mediterranean, and the Arabians in the Red Sea, Persian Gulf, and Indian Ocean, at once engrossed in their own hands the whole of the trade between the Mediterranean countries and Southern Asia, the Arabs keeping it without interruption until Da Gama opened up the route to India by the Cape of Good Hope. Ultimately, the Phœnicians and other colonies were forced to succumb to the rivalry of Assyria, Greece, and Rome; yet Tyre was not finally destroyed until taken by the Crusaders, who would appear to have been often strongly influenced by commercial motives, or were at least ever ready to advance the commercial interests of the mediæval Italian States in the 12th century. During the 300 years subsequent to Da Gama's successful enterprise, the Red Sea and Persian Gulf routes gradually fell into disuse, but now are regaining their former importance; and to secure them against all danger as the future highways of the rapidly increasing commerce of Europe and America with Asia and Australasia, has become one of the highest political duties of our age. Commerce always sets steadily towards the shortest routes, and under the pressure of the competition of modern Europe for the commerce of the East, the Euphrates Valley, which is the shortest road between the Mediterranean and Persia and India will, Dr. Birdwood thinks, within another generation, become the chief commercial road between those countries and the West. Commercial supremacy, the only sure foundation of political supremacy, is absolutely dependent on the opportunity of roads and markets, or strategical points and communications, as military men call them. Indeed, war is only another form of commercial rivalry, seeking by violence the same advantages which commerce often far more surely wins, by its slower, deadlier sap. It was of comparatively little consequence that the Egyptian Government and the Medo-Babylonian monarchy were overthrown, or that the ancient Tyre was twice razed to the ground; for, while the commerce of India still went by the Red Sea and Euphrates Valley, the people prospered; but when the Portuguese outflanked these routes by doubling the Cape, Egypt became "a base kingdom," and Babylon "a refuge for the wild beasts of the desert," and Tyre "a place to spread nets upon." If "Peace has her victories no less renown'd than war," its defeats also are more terrible and crushing, and far more enduring in their disastrous results. The discovery of Da Gama made the whole of Western Asia a desert, and impoverished all the countries of the Mediterranean for nearly three centuries.

JAPAN SILK TRADE.

The writer of the notice upon the Japan silk trade, from 1874 to 1877, appended to Sir H. Parke's report upon the general commerce of Japan, states that one important feature in the period under review is a marked decrease in the silkworm disease. In 1875, a great step was made towards the regeneracy of the yellow and other European breeds. This result has been obtained by a more and more general application of the microscopical selection after Pasteur's method. The equilibrium of production, which had hitherto to be maintained by the importation of Japanese and other foreign seeds, was then to a large extent restored by the indigenous breeds. In Tuscany, and in the Cerennes, for instance, silk growers using one-fourth less eggs than in the previous year obtained in 1875 a crop of cocoons equal in quantity and superior in quality to that of 1874. When the Japanese breeds were predominant, as in Spain, Lombardy, Venetia, Syria, la Drome, and l'Ardèche, the result was precisely the reverse.

The best qualities of Japanese silkworms' eggs are imported into Italy, which accounts for the yield being so much better there than in France. On the other hand, France having in 1874 and 1875 placed more reliance in her own indigenous breeds, whilst Italy went on using by far the greatest part of the export from Japan, the average quality of cocoons was much better in France than in Italy; and the prices offered by the silk reelers having induced many silk-growers to reel their own cocoons, there was, especially in Italy, a large production of those inferior silks called "Mazzami" or "Pagnetailles." Taking as a point of comparison the figure which is assumed to represent production before the invasion of the silkworms' disease, it appears that the decrease in the European crop, which, in 1873, was still 20 per cent., was only 7 per cent. in 1874, and 17 per cent. in 1875. It is recorded that in Piedmont the crop of 1874, had it not been at the last moment interfered with by inclement weather, would have been one of the most plentiful of this century. As regards the retrogression in 1875, it is attributed to the general predominance of the Japanese breeds in Italy. Production, as far as can be judged by exports, increased in China, whilst in Japan it remained almost stationary.

Before entering upon the subject of consumption, the writer of the notice compares the new with the old organisations of labour on the continent, and their bearing on the silk trade. Until quite recently the silk industry of Lyons was conducted on the principle of the greatest possible division of labour. The manufacturer did neither reel, throw, dye, nor weave silk. All the machinery, all the labour required for the execution of his orders, he found outside ready to his call, and he paid it at so much per weight or measure. To the middlemen who solicited his patronage, all he had to supply was his own pattern and the raw material, which he seldom bought beyond his present requirements. His stocks of manufactured goods, when he had any to dispose of, he sold on the spot to the commissioners and purveyors of the retail trade. So simple was his establishment, so well calculated was it to reduce his risks to a minimum, that he could do what the master of an iron or cotton factory could not—he might strike or resume work almost at his pleasure, and against the rising exigencies of labour, as long as labour was divided against itself, he used that power freely and efficiently. Now, a fact upon which it is not necessary to dwell long, for it forms, indeed, a prominent feature in the history of our time, is the growing strength of the organisation of labour against capital. Since 1830 every revolution, every popular rising in Europe, has added to that strength. Meanwhile, competition in trade was increasing, and it was opposed by larger and larger associations of capital, which gradually led to the introduction of the factory system in the silk industry. There are now to be seen on the Continent factories, within the precincts of which the process of manufacture is carried through all its stages, in which silk comes in at one end in its cocoon state, and goes out at the other as a perfect tissue. Such complete establishments, however, are exceptional. As a rule, reeling, throwing, and dyeing remain distinct and, more or less, independent branches of the silk industry; but, in most cases, and especially for the production of plain black and coloured piece goods, manufacturers possess their own weaving looms, and the weaving of silk has, to a large extent, been removed into the country, where labour was, at first, much cheaper and more easily controlled than in the great industrial centres. During the war of 1870-71, the working population having been dispersed, and no new hands apprenticed, the factory system was for a time paralysed, but soon recovered its efficiency.

One other effect of the war was a sudden, but steady, increase in the consumption of woollens as an article of dress, at the expense of silks, and, after the lapse of six years, this is still the bane of the silk trade. The advantages and drawbacks of the factory system are well known. In prosperous times, it gives the manufacturer a vast power of action; in hard times, it reduces him to

the alternative of overproducing or breaking up his establishment. Hemmed in on all sides, after the war, by the competition of wool, the silk manufacturer could only save his industry by a large production of cheap goods. But how could his goods be made cheaper? On the side of labour, retrenchment was forbidden; now, disciplined as an army, labour treats with capital as equal with equal. The manufacturer's difficulty had, therefore, to be solved at the expense of the raw material.

If, under the present circumstances, the writer of the notice cannot anticipate a large and early increase in the production of Japan silk, he yet, taking it as a whole, reports an improvement in its quality. That the export of silkworms' eggs, when it was very large, told in the quality of silk, is most certain. The large supplies brought to the Yokohama market during the present season have taken everybody by surprise. There is good reason, indeed, to believe that production begins to increase. In the great Hanks district of Joshiu, Shinshiu, and Bushiu, the cultivation of the mulberry has undoubtedly increased. As in a recent trip from Yokohama to Kobe overland, by the Tokaido, the writer travelled through provinces which have not yet been known as silk-growing countries, a great many new plantations of mulberry trees were visible; but what was most apparent was the wonderful development in the cultivation of the tea plant. In the provinces which grew tea when Japan was opened to foreign trade, the production of that staple has enormously increased. In those which produced neither tea nor silk, but could grow either, tea had the preference, probably because the tea culture is sooner learnt than the silk culture, and promised a more immediate remuneration. On the other hand, it was said that tea no longer pays so well as it did at first, and this fact, if it assumes a permanent character, may eventually react in favour of the growth of silk.

There are, it is believed, other signs which are of good augury for the Japan silk trade. In Italy the area of production may increase; in France it will probably be reduced. From China there is no further danger of overwhelming exports; her production seems to have recovered its normal state, and beyond the figure now reached, viz., 70,000 to 75,000 bales, the shipments from Shanghai are not likely to increase. But China will always beat Japan for the production of coarse silk. It is hoped, therefore, that the Government, looking upon sericiculture as one of its greatest sources of wealth will, by all the means in their power, foster the production of fine-sized raws. Unaided, the Japanese people are too poor to achieve any large improvement in that direction; it can only be brought about by a liberal admission of foreigners into the interior, and by substantial guarantees being given to the capital required for the establishment of large factories. In the opinion of the best judges, there is in Japan a tremendous waste of cocoons caused by defective modes of smothering, drying, storing, and reeling, and herein foreign skill would effect a great saving.

CORRESPONDENCE.

NATIONAL WATER SUPPLY CONGRESS.

Will you allow me to correct a typographical error in page 22 of your publication entitled "National Water Supply Congress." I am reported to have said that the capital of the New River Company was stated in the Government returns at 13 millions. What I did say was three millions. The "expenditure" set down in "No. 2 capital account for the half-year ending 31st December, 1876" is £2,892,802. The value of the property, taking the last sales as evidence, and allowing 25 per cent. for compulsory purchase, is £11,377,000. The sum allotted in the estimate to which Mr. Chadwick referred was £7,434,157. As the report stands, I am made to represent the paper value as higher than the market value of the property, while I wished to show that the reverse is the case.

Francis R. Conder.

OPEN-MOUTHED PIPES VERSUS VENTILATORS.

As the result of the experiments made at Kew by the judges of the Sanitary Institute with ventilators as against plain pipes is still commanding considerable attention, will you permit me to publish the following results, showing the effect the shape of the outlet has upon the speed of the up-current.

I have recently put up at my house a four-inch pipe about 13 feet in height, and whose top stands about two feet above the ridge. At 8 p.m. last night I tried the up-current, first with the plain pipe, then I put an expanding or trumpet-mouthed outlet perpendicularly upon the top of the pipe. This, being tried, was taken off, and a Boyle's 10-inch soil-pipe ventilator with three-inch pipe attached put on; this being also tried, was taken off in turn, and a three-inch Banner's cowl was then tried, and the following are the results, showing the number of feet per minute which each produced of up-current:—

Plain open pipe.	Pipe with trumpet mouth.	Boyle's.	Banner's.
200	400	300	200
200	300	200	170
200	300	200	160

In this case the plain upright pipe with expanding outlet gave much the best results, and when at 4 p.m. to-day I repeated the experiments, the trumpet outlet gave much the quickest up-current. The plain pipe again gave 200, but Banner's cowl only 200, 170, and 160. The open joint where cowls turn helps to hurt their effect. Yesterday I tried a drain at Dr. Cassell's house, Newton-terrace, here, which has the soil-pipe going up the centre of the house to act as its ventilating shaft, and which soil-pipe carries off the rain water from the centre gutter; the anemometer showed an in-current of fresh air into the drain through the ventilating trap of 300 feet per minute, but after running hot water down the soil-pipe the in-current rose to 500 feet.

W. P. Buchan, Sanitary Engineer.

21, Renforth-street, Glasgow, August 10th.

GENERAL NOTES.

The Plasterers' Company.—The following is the result of the seventeenth annual competition for prizes offered by this Company in connection with the Science and Art Department. For an original design in monochrome for a ceiling of a room with centre for chandelier, first prize, C. E. Wilson, of the Sheffield School of Art; second, J. M. Benson, of the National Art Training School, South Kensington. For an original design modelled in plaster for a portion of a ceiling centre, first prize, H. Harvey, of the National Art Training School, South Kensington; second, W. Wallen, of the Westminster Royal Architectural Museum School of Art. The competition drawings and models are now on view at the annual exhibition of national art student works, South Kensington.

Paris Exhibition.—The following are the dates of the Congresses to be held in connection with the Exhibition:—Congrès des Sciences Anthropologiques, 16th to 21st August; Congrès du Commerce et de l'Industrie, 16th to 22nd August; Congrès de Botanique et d'Horticulture, 16th to 23rd August; Congrès de Météorologie, 24th to 28th August; Congrès Géologique, 29th August to 4th September; Congrès de la Propriété Industrielle, 7th to 17th September; Congrès de la Géographie Commerciale, 9th to 14th September.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,344. Vol. XXVI.

FRIDAY, AUGUST 23, 1878.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

NATIONAL WATER SUPPLY.
HEALTH AND SEWAGE OF TOWNS.

The Reports of the Congresses on the above subjects have been published in pamphlet form, and each report can be obtained at the Society's House, price 2s.

GROSVENOR HOUSE.

The Duke of Westminster is desirous that designers, artisans, and the like, employed in any branch of Art applied to productive industry, should have the opportunity of inspecting Grosvenor House, with its Works of Art, daily, including Sundays, during the months of August and September, 1878, from 2 p.m. to 6 p.m. He regrets that, for want of room, he cannot extend the admission beyond the persons specified.

A number of tickets of admission have been placed in the hands of the Secretary of the Society, for distribution among persons answering to the above description.

Such persons can obtain tickets on application at the Society's house, by bringing with them a paper containing their names, addresses, and occupations.

Each ticket admits a party of four.

There will be no admission on wet afternoons.

CANTOR LECTURES.

THE APPLICATION OF PHOTOGRAPHY TO THE PRODUCTION OF PRINTING SURFACES AND PICTURES IN PIGMENT.

By Thomas Bolas, Esq., F.C.S.

Lecture VI.

Other methods of producing photographs in pigment. Dusting-on process. Autotype printing.

You will remember that, last week, I spoke of the the use of india-rubber rollers for the inking of collotype plates, and that I recommended a roller made with a thin surface of red india-rubber on a body of the glue and treacle composition used for typographic rollers. At the conclusion of the lecture, Mr. Dallas informed me that Messrs. Blades, East, and Blades, of Abchurch-lane, have recently introduced into commerce a roller consisting of a thick layer of red vulcanised india-rubber on a rigid stock. These rollers are made under a patent of Mr. Lanham, manager to the above-mentioned firm, and will, I am convinced, prove of very great value to lithographers as well as to collotypic printers. The manufacturers have kindly lent me some specimens of their rollers, which are now on the table.

Up to the present time we have been studying the means of producing, by the agency of photography, printing surfaces from which copies might be obtained without any further intervention of light; but in this, the last lecture of the series, I want to call your attention to some methods for the production of pictures in pigment, which necessitate a direct and separate action of light for the production of each picture.

Here is a glass plate, and I pour on it a mixture containing 25 parts of glucose, 4 of honey, and 4 of ammonium bichromate, dissolved in 120 of water. I lay the plate on the hot-water apparatus, and it will be dry in a few minutes. If the dried plate is exposed to the atmosphere, it will absorb moisture, and the whole surface will become sticky. Now that the plate is dry, and while it is warm, I will place it behind a transparency and allow a strong light to shine on it through the transparency. The joint action of light and ammonium bichromate tends to make the honey and glucose insoluble; or, at any rate, it prevents these materials from absorbing moisture from the air, as they tend to do naturally. Let us now take the plate out of the frame and examine it. A very faint image may be traced thereon, but only those of you who are near can see it. Now, what is happening to this plate? Those parts which were protected from the light are absorbing moisture from the air, the honey and glucose being here unaltered, while those parts which were exposed to the full action of the light refuse to absorb moisture, and those parts which have been protected from the action of a part of the light, absorb an amount of moisture proportionate to the degree of shade afforded by the half tones of the transparency. Now note the effect of dusting powdered black-lead over the plate, and rubbing it on with a soft brush. Those parts which are dry refuse to take the black-lead, while those parts which are moist hold an amount of black-lead proportionate to the degree of moisture. Now look at our plate, and you will see that there is a picture showing all degrees of light and shade, the picture being formed of black-lead, held by the various degrees of moisture absorbed from the air. The next step is to coat the plate with collodion, and to immerse it in water, in order that the yellow ammonium bichromate may diffuse out. Other pigments than black-lead may be employed, and the pictures may be made on paper or other materials, but the dusting-on process, although interesting as a means of producing permanent photographs, is not worked commercially to any great extent.

We now pass on to the study of a process of

much greater importance than the dusting-on method, namely, the so-called carbon process, or the autotype method. The first step in this process consists in coating one side of paper with a tolerably thick layer of gelatine, to which a little sugar has been added, together with sufficient pigment to strongly colour the mixture. Here is a piece of the "pigmented tissue," as it occurs in commerce. To prepare it, about three parts of gelatine, and one part of sugar, are dissolved in water, and the pigment is added in sufficient quantity. A band of paper is then drawn over the surface of the mixture in such a way as to coat its surface with a uniform layer of the composition. The pigmented tissues are prepared on a large scale by the Autotype Company and others, and few will care to prepare their own tissue, excepting for experimental purposes.

To make the tissue sensitive to light, it is soaked in a solution of potassium bichromate, containing about three and a half per cent. of the salt. You see that this piece of tissue has now become quite flaccid from the absorption of the solution. So I scrape off the excess of solution by drawing the tissue over the edge of the dish, take it out, and hang it up to dry. When dry it will be ready for exposure under the negative. Here is some which has been previously dried, and I will put a piece under this negative and expose to the action of a bright light. In the ordinary process of silver printing, one can watch the progress of the operation, and can easily tell when sufficient exposure has been given. Not so in the case of the tissue, as it undergoes no visible change by exposure to light. Here is a little tin box having a small glass window in its lid, and a strip of sensitive silver paper can be drawn forward under this window. The lid having been shut down so as to press on the strip of silver paper, the tin box is exposed to light simultaneously with the printing frame containing negative and tissue, and as soon as the silver paper has acquired a certain standard tint or degree of darkness, it is considered that the tissue has had one unit of exposure. The silvered paper is then drawn forward, so as to expose another portion, and so on until as many units of exposure have been given as the tissue is known to require when exposed under the negative in hand. This is quite easy in practice, as a little experience will enable one to judge how many units of exposure, or "tints," will be required by each negative, and one guide-box, or "actinometer," serves for any number of printing frames. The tissue which I just placed under a negative has now had sufficient exposure to light; I take it out, soak it in water until it is soft, and then, while it is still in the water, I bring it in contact with a piece of paper which has been coated over with a thin layer of insoluble gelatine, so as to make it impervious to water. The tissue and the impervious paper are drawn out of the water together, and an application of the squeegee now removes the excess of water which remains between the two surfaces, and the exposed tissue adheres to the impervious paper. Let us allow them to remain in contact for a few minutes, in order that the tendency to adhere may become greater.

Bear in mind that the bichromatised and pigmented gelatine becomes insoluble by the action of light shining through the negative, and the depth to which this insolubility extends is dependent on the amount of light which has acted on it. On those parts of the tissue which have been exposed to much light, a thick layer of gelatine is made insoluble, while on those parts which have been exposed to only a little light, the insoluble layer is very thin.

Now, we want to wash away the soluble portions of the gelatine from the exposed tissue, and to leave the portion made insoluble by the action of light, just as in the Woodburytype process; but if the exposed tissue were put directly into hot water, the insoluble image would become undermined by the dissolving away of the gelatine from underneath it, and it would become destroyed for want of a support sufficiently strong to hold it together. You can now understand why the exposed tissue was mounted on a piece of impervious paper, this being intended to hold together the insoluble gelatine image during the treatment with warm water. Here is the tissue, which I mounted on a piece of the impervious paper, or single transfer paper. Notice the effect of putting it into a dish of warm water. You see that the soluble gelatine in which the insoluble image is embedded melts and exudes from under the edges of the paper, while the application of a very little force will now enable us to separate the two papers, viz., that on which the tissue was originally made, and the impervious paper on which the tissue was mounted. Under these circumstances, the insoluble image naturally adheres to the impervious paper, or single transfer paper, but it is at present clogged up by some of the soluble gelatine, which must be removed by rinsing with warm water. You see that this soon dissolves away, leaving the image on the single transfer paper. Here it is. This image consists of varying thicknesses of gelatine made insoluble by the joint action of light and a bichromate, but as the gelatine contains a black pigment (carbon), it shows on the paper as a picture in black and white. This is the simplest form of the carbon or autotype process; it is known as the single transfer process, and, as a little consideration will show you, it requires a reversed negative; that is to say, a negative in which the sides of the picture are reversed, left-hand being where right-hand should be, and right where left. This disadvantage is obviated by the so-called double transfer process. According to this method, the picture is not developed on the support which is ultimately to hold it, but on a temporary support, from which it is removed by the application of a sheet of adhesive paper.

Yonder, at the other end of the table, stands Mr. Foxlee, surrounded by carbon printing materials of every kind, and he has kindly consented to demonstrate the principal phases of the carbon process with some materials and partly finished prints, for which I am indebted to the Autotype Company. I see that, while I have been talking, Mr. Foxlee has been busy; he has mounted some pieces of exposed tissue on waxed zinc plates, some on collodionised opal glass, some on single transfer paper, and others on a material known as Sawyer's flexible support, and which I shall describe to you directly. To all of these the wet tissue

adheres perfectly well, and as the prints are now ready for development, Mr. Foxlee is putting them into trays of warm water. Notice how he strips the paper off as the soluble gelatine dissolves, and how the pictures will gradually unfold when he rinses them with warm water.

I want you now to take notice of the flexible support introduced by Mr. Sawyer, the talented director of the Autotype Works. Its basis consists of hard paper coated with a layer of insoluble gelatine. This is floated on an alkaline solution of shellac, which softens the gelatine on the surface bonds with it, and forms a thin film of varnish over it. When dry, the flexible support is rubbed over with a weak solution of wax and resin in oil of turpentine, in order to prevent the possibility of permanent adhesion between the flexible support and the gelatine picture. The great advantage of this support consists in the fact that the fine details of the gelatine picture are not crushed against a rigid surface in the mounting and subsequent treatment. This will be illustrated further on.

Mr. Foxlee has now finished developing his pictures—those developed on single transfer paper are finished, as after development they only require rinsing in cold water, a dip in alum solution to harden the gelatine, and then a second rinse to remove the excess of alum. You see that among the single transfer prints which Mr. Foxlee has developed are some very fine large portraits, but Mr. Foxlee makes large prints as easily as others make small ones; he thinks nothing of making them three feet by four feet, or even larger. Now, here are the prints which Mr. Foxlee has developed for double transfer—some on zinc plates, some on Sawyer's flexible support, and others on opal glass. I see that he has a number of pieces of the so-called double transfer paper in a dish of warm water before him. This paper is coated on one side with gelatine, to which a little alum or chrome alum has been added, and when it is put into warm water the surface becomes sticky, but the gelatine does not dissolve. On each of these prints, which have been developed on the various supports, Mr. Foxlee is placing a sheet of the wet and sticky double transfer paper, and after having ensured contact by means of the squeegee, he puts them aside to dry, and when they are dry it will be found that the paper can be easily stripped from the temporary support, carrying the print with it. In order to illustrate this, Mr. Foxlee has provided himself with some transferred prints, already dried, and ready to strip from the temporary support. You see that Mr. Foxlee is now stripping the prints from zinc plates; he just inserts his thumb-nail under one corner, and then a slight pull brings the print off. Now he is similarly stripping prints which have been developed on collodionised opal glass. Notice what a fine enamel-like lustre they have. Next, he will separate the prints from Sawyer's flexible support. You see how easily they separate, and if you carefully examine the flexible support from which a print has been separated, you will be able to trace a faint intaglio image of the print, showing how the image sinks into, and is protected by, the flexible support. The single transfer process and tissue making are now untrammelled by patent rights; but the double transfer method and the manufacture of Sawyer's flexible support are subject to patents held by the Autotype Company, and licenses for the working of double transfer are granted on almost nominal terms.

Mr. Foxlee will now illustrate to you the method of making carbon pictures on ivory and on artist's canvas. He has developed pictures on the flexible support, and while they are wet he lays them down on the ivory and on the canvas, which, by-the-bye, have been previously prepared with a thin film of partially insoluble gelatine, and makes contact by means of the squeegee. When dry, the flexible support can be peeled off, leaving the print on the ivory or on the canvas. You see that Mr. Foxlee is now stripping the flexible support from some specimens which he has previously prepared. Very beautiful transparency pictures can be produced by the carbon process; it being merely necessary to squeegee the exposed and wet tissue on to a piece of collodionised glass, and after a few minutes, to develop in warm water. Mr. Foxlee is now developing some, and when they are finished I will exhibit them to you by means of the magic lantern. The process I have described to you is generally known as the carbon process, it having arisen out of an earnest desire to obtain non-fading photographs; and as carbon is the type of a non-fading pigment, it was naturally used at first, either in the form of a lamp-black or of Indian ink. As time went on, people wanted other tints, and it was considered especially desirable to imitate the purple tint of a gold-toned silver print. This was done to perfection by the use of a mixture of lamp-black, indigo, and cochineal lake, but, unfortunately, the prints so coloured were found to change their tint owing to the fading of the cochineal lake. Attempts were soon made to replace the fugitive cochineal colour by permanent reds, and notably by madder red or alizarine, but until recently with only partial success, as ordinary madder lakes work mischief in the tissue. Mr. Sawyer has, however, recently overcome all difficulties with regard to the use of alizarine in tissue, and alizarine is now used in all the tissue of the Autotype Company, which imitates the "photographic tone," or series of tints shown by silver prints.

The kindness of many eminent carbon printers has enabled me to show you a splendid collection of prints to-night. The Autotype Company have lent me several hundred of their well-known and admirable productions, ranging in dimensions from four feet high to pin or brooch size. Messrs. Braun and Co., of Dornach, have kindly lent me specimens which are of the first order, and I want you to especially notice the excellence of two untouched portraits kindly lent by the Woodburytype Company. Among the more recent carbon painters we have Mr. Witcombe, of Salisbury, who has sent a very fine collection of small prints, but as they arrived too late to be displayed, I have placed them on the table. You will see over yonder a frame containing some prints made by a process due to Sir Thomas Parkyns. The carbon prints being covered with a film of coloured collodion, very striking effects are produced, imitating moonlight and other effects.

Mr. Le Neve Foster has lent me a carbon print made by Mr. Pouncy twenty years ago, and if you look at it you will see that in detail and delicacy of gradation it is quite equal to the productions of more recent times; and I have here some carbon prints which were made by Mr. Foxlee, nearly as long ago. I should like you to look at these, as they are an illustration of what was done during the infancy of carbon printing.

In these lectures I have not attempted to give anything like a history of photo-typography; I have not even mentioned many important processes. Had I referred to all, the six lectures would have been merely an index to the work which has been done. I wish I had been able to give you more details of the processes described, but you must bear in mind that days rather than hours are required for properly demonstrating the simplest photo-mechanical process, and real working and practical demonstrations can only be given in the quiet of the laboratory, and to a very small number of people at a time.

Before you go, I want you to appreciate the help which Mr. Barker and Mr. Debus have afforded me, not only in work incidental to the delivery of the lectures, but also in the work of preparing materials for them. Do not forget also the thanks which are due to Mr. Foxlee, for his admirable demonstration of the carbon process.

UNIVERSAL CATALOGUE OF PRINTED BOOKS.

The following evidence was taken before the Committee on this subject.* Present—Mr. W. Hawes, Deputy Chairman of the Council, in the chair; Mr. Edward Arber, F.S.A., Mr. George Bell, publisher (London and Cambridge), Mr. George Bullen, of the British Museum, Mr. E. A. Bond, of the British Museum, Lord Alfred S. Churchill, Mr. Hyde Clarke, Sir H. Cole, K.C.B., Mr. E. B. Nicholson, of the London Institution, Mr. E. C. Tufnell, Mr. Cornelius Walford, Mr. J. A. Youl, C.M.G.

Mr. George Bell, publisher in London and at Cambridge, examined:—

1. **Sir H. Cole**—You perhaps have heard that before Mr. Pickering, of Piccadilly, died, he made a calculation to the effect that he could never be sure of selling 250 copies of a standard book, to supply the country and London?—I never heard that, but it is very likely that he made such a remark.

2. He said the decline in the formation of private libraries had been so great in his experience, that he never felt sure that he would sell 250 copies of a standard book?—That is my own experience with books of the highest class.

3. It is important to bear in mind that the completion of the universal catalogue for the use of the public and the public libraries is one thing, and the printing of the catalogue in the cheapest possible way, to meet a large sale amongst the public, is another?—Certainly.

4. Is it your opinion that there would be any sale among the public for such a catalogue?—For a book in the form of the specimen?

5. First, I will ask you the general question?—For a general catalogue I think there would be.

6. You think the catalogue could be published at a reasonable price?—I think it could; but I think it should take the whole range of literature up to the present time. Lowndes has done this to a great extent, but imperfectly, in his "Manual of English Literature," and there is a good, steady sale for his book. The thing to do, in my opinion, is to bring Lowndes down to a more recent period.

7. Is Lowndes sufficiently complete to supersede what is contemplated now?—Oh, dear, no.

8. In Lowndes the titles are arranged in some sort of classification, I believe?—They are mostly arranged alphabetically.

9. If the titles of all books in the English language were printed and collected together, they could be printed in a form that would meet with some public sale?—Yes.

10. Have you any notion what kind of sale?—I think I may say that if you would complete this catalogue down to the present time, in your shape, I should be very likely to pay for the use of it; in the shape that Lowndes has adopted.

11. Carry it on and reprint it?—Reprinting Lowndes, making use of the other materials, and so perfect the catalogue.

12. That is very important. Do you say that you would yourself undertake the cost of printing?—I would pay the cost of printing after bringing the materials together. I have long had the idea of bringing Lowndes' work up to the present time. Such a catalogue is constantly wanted in all public libraries.

13. Have you any idea of the extent of the number of titles?—Lowndes, I should say, has about 4,000 pages, and it will take at least double that to contain all the English books.

14. It is the same sized page as the specimen?—Very much closer than that. I think there are about 20 titles in each page.

15. **The Chairman**—I think, pursuing the line that we are on, before we get to another, I may ask you whether you think that this catalogue might be arranged in a form that would meet the requirements of the public and the requirements of the librarians; that is, the requirements of the public library, and the requirements of the public?—I do not think it could. I think if you adopt this as it is, printed on one side, that you would find it much too expensive to meet the general wants. You get only about five titles in a page there.

16. **Sir H. Cole**—In preparing that specimen, the intention was to have it printed in such a form that it could be easily used in the British Museum. Now, I understand from you, that you are of opinion that it would be desirable to keep the two things distinct?—I think so.

17. You, therefore, being in favour of printing for the public libraries, would agree that it should be printed somewhat in that form—instead of being in that quarto size it might be in foolscap size—I mean a foolscap page—which would take a little more; but, assuming that it is desirable to have a separate print for the public libraries, of course it would be printed on one side?—One side only, for the sake of admitting various arrangements.

18. You have already said in your return* that you think you would go to A.D. 1600 as the first period?—I think so; we have got a good deal of that done. I think you had better go to 1600.

19. You are not of opinion that the first period should stop at 1499?—I do not see why it should stop there.

20. **The Chairman**—That is 1500, instead of 1600.

21. **Sir H. Cole**—Mr. Bell contends the catalogue should be printed separately after 1600.—Printed separately?

22. That it should be printed separately; that you should bring the titles down from the time of A.D. 1499, and that afterwards you should go on as far as you can;

* See *Journal*, February 15th, 1878.

* Returns made to questions issued by the Committee. See *Journal*, February 22nd, 1878.

though I do not see much difficulty myself in going from the beginning. It may be a matter of doubt about Caxton's Reynard the fox, and where it should come—but in the absence of a writer you would be content to put it under Caxton, I suppose. You, therefore, think that it should be brought down to A.D. 1600?—I do not see any advantage in beginning it at 1499.

23. You say you have not given attention to the cost of classification. I will not ask you any questions upon that—but you say that you think any notes should be given in the language of the country which makes the catalogue?—I think so.

24. Sir James Lacaita, who is a high authority, has recommended that it should be in the universal language of Latin?—I believe he has.

25. **Lord A. Churchill**—You recommend the language of the respective countries?—I do.

26. **Sir H. Cole**—You would not use the same type for text and notes?—I think the notes should not be made so prominent.

27. Well then, as respects the mode of printing, you prefer getting an estimate from a printer of renowned accuracy?—I think so.

28. You recommend that we should enter into communication with various societies for promoting special branches of literature, and also the Universities?—Yes.

29. Is it your opinion that the Universities would give any help?—I think that Cambridge would.

30. What kind of help?—They would, I think, give you any special knowledge they have of scarce books, but questions might arise about the method of writing out the titles, and arrangement.

31. **Mr. Tufnell**—Mr. Bell, you adhere to your former answer, that some return of the cost of completion would be obtained by allowing publishers to print in their own form?—I do not say allowing the publishers generally, because I do not think they would.

32. Allowing you?—Yes; because I have means of making use of it. I do not assume anyone else would. I should be willing to pay for the use of it in order to complete Lowndes up to a recent date.

33. **Sir H. Cole**—He has told the committee he would like to have the right of making use of it.

34. **Mr. Le Neve Foster**—It would not be worth pirating by anybody?—You would hardly maintain a copyright in the titles.

35. **Mr. Walford**—The object would be to make the widest possible use of the book, I take it.

36. **Mr. Foster**—No doubt.

37. **Sir H. Cole**—The first catalogue being printed on one side, you could provide for any possible classification by cutting up the titles; as, for instance, if you wanted a chronology without reference to subject, that would be one cutting up; if you wanted it alphabetical, that would be another; if you wanted it under subject matter that would be a third; and for people who are curious about printers, there might be a fourth classifiation under printers' names, so that at least four sets would be necessary for anybody who wanted to make the best use of it?—The fullest use of it would require four sets.

38. I think the reference does not go into other questions than that, but I suppose we may ask a question. Is your opinion generally favourable to the production of the catalogue?—I certainly feel unable to offer an opinion upon that, because I really am quite at sea as to the number of titles that you want, or whether beyond A.D. 1600. Then comes the question of expense; if you require £20 for each copy, then I think that it would be doubtful whether you would find buyers sufficient to pay the cost.

39. Have you ever computed what it costs to make four manuscript multiple copies of each of the titles of the books that come into the British Museum?—No.

40. They could tell at the British Museum if they looked. You are aware that at the British Museum the title of every book that comes in is copied down by a competent person. I do not know how high is the ability that they require for taking the titles accurately; it must be technical work, some of it, and then that they make four copies. Well now, would it be consistent with your experience that it would cost perhaps more, but a very little more, to put those titles into type at once; and instead of printing the four copies by hand, then you would have about 50 at the same price?—I really cannot say; they first of all have to write out the title correctly according to certain rules; that is the most expensive part, as there are fixed rules according to which the titles are to be registered

41. Cannot you imagine a compositor—a skilled man—at once composing a title from the title page?—No; I think he would need to be directed.

42. Do you think he could not be trained to do that?—I think not; in books in Latin, for instance, or in scientific books, he would not know exactly the bearing of the rules.

43. You are of opinion you must have the intervention of a scribe before you put it into type?—That is so.

44. You do not speak as to the cost of collecting the titles?—I think roughly 6d. a title would cover the cost.

45. **The Chairman**—Piece work?—If you set a man to collect the titles, I think you might get them at a cost of 6d. for each title.

46. **Sir H. Cole**—You have already said that a printer would not do it?—I do not think he would; an accomplished reader might.

47. You are aware that there are various mechanical type-composing machines?—Yes. I think the difficulty in composing by machine is the examining of the manuscript. You can compose quickly from a printed copy.

48. You are aware of a sort of auto-type printing machine very commonly in use, a system that saves a printer.

49. **Mr. Foster**—The Remington type-writer. It is in use by a great number of people.

50. **Sir H. Cole**—You know the writers of the British Museum who now makes the titles—it surely would not be any great feat to be able to put the title on the instrument?—No, but he would make only one copy at a time.

51. Which would give many repetitions. I have only asked you these questions to show that the modern method of doing this regularly is becoming distinct from the old style of doing it 300 years ago?—Still there are difficulties in the way of all these machines. The printers do not get them into use thoroughly.

52. You know it is a fact, I suppose, that half the *Times* is composed by machinery?—I do not know that.

53. **The Chairman**—By a composing machine.

54. **Sir H. Cole**—Yes.

55. **Mr. Bell**—In the Catalogue of Works of Art the titles, as far as I can recollect, were obtained in the first instance from the British Museum catalogue, they were then put into type, and the list was sent to other places. The titles were obtained at a cost of 6d. each.

56. **Lord A. Churchill**—Do you think you could do it for 6d. a title?—I cannot say.

57. **Mr. Foster**—Not bring it out for 6d. a title, but get the information.

58. If the British Museum Library Catalogue were printed, a large proportion of your work would be well started, would it not?—Yes.

59. **Lord A. Churchill**—The Duke of Marlborough has got a very large library, shut up; nobody knows what there is there.

60. **The Chairman**—Do you know at all the number of volumes?

61. **Lord A. Churchill**—About 20,000 volumes, I suppose. I have no doubt that the Duke would give facilities.

(Mr. Bell retired.)

Cornelius Walford, Esq., Barrister-at-Law, examined:—

62. I think you have had considerable experience with catalogues?—I have had considerable experience in my own private library, which consists of some 30,000 volumes, tracts, and pieces—many of them out-of-the-way works, pamphlets, prospectuses, folio-sheets, and things which are not generally catalogued.

63. **Sir H. Cole**—Do you think the experience you have had in making the catalogues, such as you have heard described, could he applied to the completion of a work of this sort?—I think it could. I am familiar with the catalogues of many puhlic and private lihraries.

64. Can you tell us what is your opinion as to the best way of proceeding?—I think the getting the information, that is, the titles of the books, would he a matter of small cost, comparatively; and if you will let me I will tell tell you why; but I do not want to anticipate your questions.

65. The next question to ask is, what you mean by a small cost?—I should have said not more than 3d. per slip. When I use the word "slip" I mean a slip of this sort [producing one].

66. Will you hand in that copy?—That is not quite complete; it is intended to be of the size of the British Museum slip.

67. I am sorry to interrupt you, but we shall have the evidence-in-chief of Mr. Bullen.—I want to show that process in relation to any suhject, and I think you will find I am not occupying your time unnecessarily. I have mentioned the cost as 3d., where you have to pay for them; hut I have the titles of all my out-of-the-way books and pamphlets ready for the process which I shall submit to you for adoption. They are ready at this moment, hut waiting to he lent or applied in a way that may be afterwards determined.

68. That is an important matter?—I mention that because when 20,000 titles were mentioned, one could not help feeling a little startled to think how very far it was from the view that I——

69. I think Mr. Bell meant 20,000 titles up to a certain date?—I want to hring before the committee, if I could, the magnitude of the work, and I think I may fairly say that three million titles would be the estimate, of which one-half, I think, may he obtained without any cost whatever.

70. You would only want one title to a work, although it might have ten volumes?—Only one title, certainly.

71. Have you any notion of the number of works in the British Museum?—There are ahout a million and a half of works there, including pamphlets. The volumes have nothing to do with it. The "Encyclopædia Britannica" has one title, for instance, although it has 30 volumes.

72. Can you refer us to the evidence that there are one million and a half of titles?—Mr. Winter Jones is my authority.

73. The titles—and they are all catalogued?—They are all on slips in such a state that they can be arranged in any way; and, with reference to the slips, I desire really to make a suggestion. If a title he once written on a slip, I venture to say it need never be copied, and it must he written on the slip and examined, and from that slip—the slip being handed in—the catalogue can he completed in one of several ways; either alphahetically as to authors' names; alphabetically as to the titles of the hooks; chronologically—

74. Alphahetically as to the titles of the hooks?—Instead of the authors' names—I think you will see the intention—first, alphabetically as to the authors' names; next, alphabetically as to the titles of the hooks.

75. What do you mean by that?—As, for instance "Yeast" by Kingsley, the title of the book is a distinction from the other names. You will have the alphabetical title of the book.

76. The next point I am going to speak of. I will just give it again. First, alphabetical, that is the system generally used; next, the alphabetical title of books, which I have seen used.

77. The books on the subject?—I will come to the subject presently. I am speaking now of the use which the slips may be made. First, the entry in the catalogue of the author's name; secondly, the titles of the hooks; thirdly, for chronological arrangement, the date being put in the margin; fourthly, for suhject catalogue. The same slips can he used for all these four purposes, and they can be printed from. The compositor can set up from the slips and put in print. My slips go to the printer and come back again. If you have for your plan an alphahetical catalogue, you could next take the slips and arrange them into a subject catalogue, and then arrange them chronologically without any re-writing. It is a purely mechanical operation, and I am endeavouring to reduce this question which I have had so many years on my mind, hecause it will save labour, and also it saves mistakes; when the slip is once correctly written it is impossihle for a mistake to arise.

78. You would say that having got it the first time by manuscript, at all events, you would get it made perfectly accurate, then you would make as many copies of that as are necessary?—That is exactly what I would not do. I would use that slip for all purposes, never multiplying it again, except under certain conditions. For the purposes of the catalogue it would not he necessary.

79. If you follow out your process as I understand, you make a manuscript title?—On a card.

80. And that title card corrected is to be used for printing?—For first compiling or printing.

81. Then having seen that your printed copy perfectly agreed with that manuscript copy, you then and there make copies of the thing for as many purposes as you want?—That is not my suggestion; my suggestion is this? I am sorry I do not make myself more clear, that having once got the slips, that they should be kept until the plan of the work is defined; if the plan of the catalogue is defined, and they want to be alphabetical, the slip would be used in that mode; if it is decided to he chronological, the same slips would be arranged in that way, and for a suhject catalogue, the slips would be used in reference to their suhjects. But at this point there is a little difficulty ahout the slip; you would have many hooks relating to five or six suhjects, and always clearly defined in the title. In order to prevent mistakes and omissions, you must have the slips multiplied in regard to each subject. I hope I make myself clear. In all those cases you must have a multiplication of the slip, hut in no other case; the slip heing so arranged that the accuracy would he certain, and with skilled hands, the slips heing once corrected, they could he printed from, and the slips hrought back again and printed in any other form that you please, and therefore, the slips heing correct, would carry the work through all these stages, assuming they were writen with durable ink on a durable suhstance. In the British Museum the process they have is to write the titles very distinctly on thin paper, and to mount them very carefully; but I think I would remove that objection hy suggesting that they should be written on strong cardhoard, made on purpose for the work.

82. I should like a little more details about the *modus operandi* in this matter. I understand you to say that you would begin with that cardhoard and make the titles?—Yes.

83. And that the title should be the exact copy of the title-page in the hook?—I should have all the title-page—every word and sign on the title-page—except the mottoes.

84. Now, then, of course, at the very early period, before they have gone very far, you must make up your

mind how you are going to arrange other titles, and so on?—I would suggest a mode.

85. You must print as soon as possible; I do not mean to print off, but to multiply?—I think all these difficulties would be got over by the plan I propose.

86. Is there no difficulty in that?—Having got your slip once prepared, that would remain as part of the general work. First of all, by properly approaching the Museum authorities, I think you could get the million and a half slips there; that would be a very good start. I would suggest, as to the others, that you could have the great bulk of the work done under the superintendence of the librarians in charge of special collections, and by private owners, as a labour of love. I am confining myself merely to English-printed books, and not going into the universal catalogue, but speaking of the English, which, I think, is enough when you remember these will embrace three millions of titles; if you once get the million and a half of titles, you have got the work half done.

87. I must interrupt you there, because the mode of doing the thing is very critical. You have got your million and a half from the British Museum, and you would follow your forms——?—In reference to all those books which were not included, I venture to say that I and others know precisely where very many books are which are not in the British Museum.

88. Does the British Museum itself know with any very considerable accuracy what books it has got?—It has a slip of every one of them.

89. I infer from what you say that, having got your three millions of titles——?—The million and a half.

90. Then you would ask, say, the Royal Dublin Library, to give something?—I would ask them to fill up slips for me of the books which they have in their library not mentioned in Lowndes, or in Watt, or in Allibone.

91. Would you not get many duplicates?—It would be so in some cases, but I would throw the duplicate slips out at once.

92. I want to follow this up exactly. You have got your British Museum titles, then anything else the British Museum has not got, you will get it from the Royal Dublin Society and from Oxford, &c.?—More particularly from the private libraries.

93. Now, then, your *modus operandi* is to send empty slips to the Bodleian Library, and to ask it to tell you something which you want to know?—I think Dr. Coxe would know very nearly all the works in his noble library which are not in the British Museum Library.

94. The Chairman—He is asked to fill up those slips; Mr. Walford does not propose to ask him for more.

95. Why do you exclude the British Museum catalogue?—I do not exclude it all; they have no complete printed catalogue, and their working catalogue consists of nearly 3,000 volumes in manuscript.

96. Sir H. Cole—As it appears to me, that having got your million and a half of titles from the British Museum, and having once got them into print, you have merely to say to those places, "Will you give me any deficiencies in this list?"—But printing them would cost £20,000, and would take five or six years to do; that is my opinion, after years of careful observation and inquiry on the subject. I would print nothing preliminary; but make a general catalogue of English printed books once for all.

97. You say that it would be a frightful cost to print these titles; when you have got the million and a half titles from the British Museum. I do not know from what evidence you have got a million and a half; we are not going to print the whole of the British Museum catalogue?—There is no catalogue except the general manuscript catalogue there.

98. Then I understand you have got these million and a half of titles of the works of the British Museum, which I should expect to turn out many titles in all languages, and all books?—That would probably be so, but much more than one-half would probably be English printed books.

99. The whole of the literature of Europe in the British Museum is only equal to the literature of England?—I think that two-fifths of those titles would be set aside for the foreign catalogue. I am asked here to give evidence in reference to the universal catalogue. I think it means everything printed in the universe; that I regard as an altogether impracticable undertaking.

100. The proposition is that England shall collect the titles of all the English books, and that France should collect the titles of French books, and each other country its own literature?—That is a very good suggestion, and a very practical suggestion. I say the universal catalogue is the way not to get the thing done; it would be impossible to do it.

101. The Chairman—Produce a catalogue of all books printed in the United Kingdom?—I think that a general catalogue of English books meets the case altogether.

102. The question is, if every country will enter into a combination to produce what they have, it then becomes a universal matter?—No doubt.

103. If England produces its section, France produces the books printed in France, and Sweden may, perhaps, decline; and at all events, so far as the work goes, it is complete from the respective countries. The work here in England is simply to persuade other countries to do the like thing, not to attempt to do it?—I am very glad to hear you express that view, because I think there is a fair hope of this work being accomplished in our time.

104. Mr. Le Neve Foster—The statement seems to have gone abroad, rightly or wrongly, in this case, that it was meant to undertake a catalogue for the literature of the world.

105. Mr. Walford—If it be limited to the English catalogue, it is possible to be carried out, and will be carried out, in my judgment.

106. Mr. Foster—We call it "books printed?"—You may make it possible in seven years' time from this time to get something like an approximate catalogue of English printed books, because the work is nearly half done.

107. Sir H. Cole—You think that will cover printed literature up to what period?—Up to the present time.

108. Up to 1876?—As to the case of compiling, I will suggest that with regard to the slips that they can be used up to the very hour of going to press, and if the catalogue were printed in alphabetical, or subject arrangement, that the cards can be put in to the very last hour; further if it is alphabetical, you could print the catalogue in sections. You could print them all simultaneously, or you could print them all one after the other. You can arrange them chronologically, and you can use the slips up to the hour of revising the proofs, but I think it should be correct down to the very hour of going to press.

109. Are you aware that, for some time past, a quarter of a century, the various publishers have been accustomed to issue a printed catalogue of the works that were printed in the year?—I have all those catalogues, and very insufficient they are indeed for the purposes of the literary man.

110. The world, I hope, is going on for ever, and, therefore, whatever day you bring it up to, the next day there would be something incomplete; therefore, as a piece of business, you fix such a time as seems to be reasonable, and that is not re-duplicating the work which has been done already up to a certain period; such things as Lowndes' catalogue and the like. At a certain period anybody who wants to know what has been done in recent times has only to go to Lowndes' catalogues and find out?—I wish I could endorse what you say. I know of no catalogue which gives you a complete list of the works on any subject.

I know it is very important at the present time to have the full titles of all class works, the actual dates, the precise edition, the language in which it is printed; there is no catalogue I say which would give us that at the present time.

111. I suppose that you agree that it will be necessary to proceed by periods?—I think not. I altogether differ from the suggestion.

112. Do you think the object with which the British Museum has produced their catalogue requires you to go on with a definite period?—They have made no attempt at a printed catalogue of late years; but there are rumours of new attempts.

113. Have you read a paper that the grandfather of the present Sir Charles Dilke wrote in 1850 in the *Athenæum*, in which he pointed out the great difficulties?—I have read the paper.

114. Unless you have set your mind upon a definite piece of work you will never get anything done at all?—It is because of that that I am venturing to suggest a scheme to the committee by which the work might be done once for all time up to the first day of this year.

115. This scheme, on the contrary, says it is practicable to make the attempt to get all the titles of books printed up to any period of, say, A.D. 1600 as a beginning. No doubt, human errors and human imperfections will make a certain amount of mistakes, but, putting that aside, I take it you really once and for all will never have any more books printed in 1600; and it is definite as to the work done?—My catalogue would embrace every one of those books, and would bring the thing down to the present day.

116. Do you think it probable?—I do. I say that by a similar process the slips can be brought down to a given date, the slips all arranged by skilful persons, and you could give them to different printers if you please—letter A to one printer, who in a certain time could produce all those titles; letter B, 200,000 titles, could be handed to another printer—and having got your titles on the slips once written, all you have to deal with is the question of the money. Still there would be no difficulty in printing them in more forms than one. Now, in reference to the cost——

117. **The Chairman**—Have you the slip?—I have; and of all books which come into my library, I enter the details on a slip.

118. Of every book as it is issued?—I immediately buy the book and make a slip of it, and put it in my collection of slips.

119. **Sir H. Cole**—Trusting to your obtaining a slip of every book that goes to the public?—The British Museum has every published book. I know that they have not had all their slips for a certain period of time made up accurately. I am suggesting that the slips they have, can be utilised for the purpose of this committee. And now with regard to the cost, I think it may be fairly said that in making the alphabetical list of authors it will run into three million of titles.

120. For England alone?—I say if you are going to do this thoroughly you must give the title of every pamphlet, tract, and broadside, as well as of all well-known books. We want the titles of books that we do not know about. I will gladly contribute slips for about 800 books and tracts on insurance and kindred subjects, which are not mentioned by Allibone. You must show that you have to do with a scheme that is well defined at the beginning. If you take a period catalogue, a man loooking for any book will have to take down the several catalogues and have to go through them; if you take a subject catalogue brought down to the time the books are brought out, you have there all the works on your subject and there is no difficulty; you would have the subject catalogues brought down to the most modern time, and you would then have every person interested in a particular subject, for instance, architecture, who could use that section of the catalogue. I think it possible to do this work and to make it pay, and I am sure that in that respect you would have to make a subject catalogue, and not simply an alphabetical catalogue of authors—a series of subject catalogues.

121. **The Chairman**—Still you would require a very large expenditure at first?—There would be no large cost in getting these titles, but there would be the cost in arranging the titles when obtained, in view of completeness. I made a suggestion to the Librarians' Association on this head. Assuming that this committee worked in harmony, every librarian, knowing what are the special books in his library, might contribute those slips for the special books, or he might allow this committee to collect slips of those books.

122. **Lord A. Churchill**—How many subjects are there?—I think perhaps from four to five hundred. I think Mr. Nicholson is a better authority on that than any one here. I think there would be from 3,000 to 4,000, or 5,000 different titles for different subjects, some of them would be very large and some of them very small.

123. Could you not have a primary division of the subjects and then a division in subjects?—I will refer you to Allibone, because it is the only book which is available at the present time. I will refer to him as illustrating what I mean. He takes there, I think, 40 leading divisions; he subdivides these, and I think his is a fairly well considered scheme. I think the librarians would revise that. You would get a person or persons to arrange the slips as they come in; they would arrange them into the classes settled upon. It can be done with an amount of rapidity which is quite surprising to gentlemen who have never studied the card system. I have not my own library cards here. If I am writing upon the subject I turn up my cards and I throw them out one after the other—they all fall chronologically—and I then have the whole materials of my library on the subject in question, which I use in any way that I require.

124. Will you allow me to look at that?—Certainly.—[Card handed to his lordship.]

125. **Mr. Foster**—The same book would appear in different subdivisions?—These cards would be marked 1, 2, 3, and 4, according to the order in which you would class them out. There is another point; I would ask all the private libraries and the public libraries to contribute, and I would assign to each one a chronological number, beginning with one. I would then put against this work the number of the library where this book is to be found; this would be of especial value in respect of very rare works.

126. **The Chairman**—That goes to the advantage of having a catalogue made?—If you deal with these points, you will have all the librarians of the world helping you.

127. I think it would be necessary as we go on with the inquiry, but to-day we want to know whether we are able to obtain some idea of its cost, and that is to be done by observations of the result of your own great personal experience?—I had hoped, in suggesting this scheme, and showing how the work was half done, that the whole thing could be completed with reasonable expedition. There is a difficulty about the titles in the Museum; they are not copied in full, all of them, on the existing slips; but this could be remedied.

[**Mr. Walford retired.**]

[*To be continued.*]

The Court of the Clothworkers' Company have voted a special donation of £2,000 in aid of a building fund for the Bradford (Yorkshire) Weaving and Design School, in connexion with which they lately gave two scholarships of £25 per annum to enable students to complete their industrial education at the Textile Industries Department of the Yorkshire College, Leeds.

MISCELLANEOUS.

ADULT INSTRUCTION THROUGH PUBLIC MUSEUMS.

(Subsidised by Parliament.)

The following results, giving important information bearing on public education, are obtained as correctly as possible, from inquiry and Parliamentary returns, in the hope that they may hereafter be officially collected and published periodically, like the Registrar-General's returns. The number of visitors for the months of April, May, June, and July, 1878, are stated. When they are counted by sight the letter "S" is used, when by turnstile the "M":—

Institutions.	Amounts voted in 1877.	Number of Visitors in April.	Number of Visitors in May.	Number of Visitors in June.	Number of Visitors in July.	How counted.	Observations.
	£						
1. British Museum................	109,990	65,905	39,789	68,604	42,774	S	Return refused. Open Mondays, Wednesdays, Fridays, and Saturdays. Closed, except to students, on Tuesdays and Thursdays (1)
2. National Gallery, Charing-cross ..	6,976	100,262	74,938	93,967	95,437	S	Open Mondays, Tuesdays, Wednesdays, and Saturdays. Closed on Thursdays and Fridays. Open from 10 to 6. (2)
3. Kew Gardens and Museum	22,622	110,440	81,426	140,342	109,357	S	Open on Sundays & week days. (3)
4. South Kensington Museum	38,922	97,705	..	..	..	M	Open morning and evening till 10, on Mondays, Tuesdays, & Saturdays. Students' days—Wednesday, Thursday & Friday, 6d. entrance; open from 10 till sunset.
5. Bethnal-green Museum..........	7,600	56,420	..	..	..	M	Ditto. (5)
6. National Portrait Gallery, South Kensington	2,000	..	..	..	..	M	Return refused. Open daily except Sundays. (6)
7. School of Mines and Mining Record. Office, Geological Museum, Jermyn-street	8,997	4,490	5,120	2,775	2,142	M	Open daily, except Sundays and Fridays, and in the evenings till 10 of Monday, Tuesday, and Saturdays. (7)
8. Patent Office Museum, South Kensington	..	22,228	..	25,037	17,790	M	Open daily, Sundays excepted. (8)
9. Edinburgh National Gallery	2,100	5,896	7,445	9,356	16,797	M	(9)
10. Edinburgh Museum of Antiquities	..	4,804	7,545	9,572	18,573	M	(10)
11. Edinburgh Museum of Science and Art	10,998	23,548	26,573	29,478	39,625	M	Open daily (10 a.m. to 4 p.m.) except Sundays, and Friday and Saturday evenings (6 to 9). Students' days—Monday, Tuesday, and Thursday; admission 6d.; other days, admission free. (11)
12. Edinburgh Botanic Gardens	1,750	6,114	11,205	15,971	16,577	M	(12)
13. Dublin Museum of Natural History	1,762	11,308	11,738	11,197	..	M	Open daily, & in the evening. (13)
14. Glasnevin Botanical Gardens and Museum	2,224	24,179	15,781	25,272	32,546	M	Open daily, including Sundays. (14)
15. National Gallery of Ireland	2,389	..	..	5,724	8,670	M	(15)
16. Museum of Royal Irish Academy, Dublin	300	..	..	..	..	M	(16)
17. Zoological Gardens, Dublin......	500	13,356	9,264	13,460	15,223	M	Open daily, including Sundays. Number of visitors in July, 15,281. (17)
18. Tower of London	1,590	26,615	25,445	43,994	..	S	Open daily, except Sundays. (18)
19. Royal Naval College, including Greenwich Painted Hall....	38,051	44,172	29,788	..	85,983	S	Open daily, including Sundays. (19)
20. Royal Naval Museum, Greenwich	1,055	8,289	5,171	..	13,725	S	Open daily, except Fridays and Saturdays. (20)
21. India Museum, South Kensington	..	2,391	1,799	2,633	2,125	M	Paid for by Indian Government. Open on Mondays, Tuesdays, Fridays, and Saturdays, 1d. admission; on Wednesday and Thursday, 6d. admission. (21)
22. Hampton Court Palace..........	7,475	17,396	21,848	48,101	..	..	Open on Sundays, and on week days except Fridays. (22)

(1) The numbers are those for the corresponding month of the previous year, as given the Parliamentary Return.

(2) Open to the public 16 days in April, from 10 to 5 o'clock, 17 days in May, 17 days and one bank holiday in June, and 19 days in July from 10 to 6 o'clock. Total number of seven months to 31st, 617,090.

(7) Number of visitors for April—morning, 1,965; evening; 2,525; total, 4,490. May—morning, 2,520; evening, 2,600; total, 5,120, June—morning, 1,825; evening, 950; total, 2,775. July, morning, 1,722; evening, 420; total, 2,142.

(11) Total number of visitors during 1877, 372,585.

(14) Numbers of visitors for June—Sundays, 9,600; week-days, 6,181; total, 15,781. July—Sundays, 18,510; week-days, 6,762; total, 25,272.

RECENT ADVANCES IN TELEGRAPHY.*

By William Henry Preece, Mem. Inst. C.E., &c.

The overpowering sensation produced by the telephone, and other acoustic instruments that have followed in its wake, has led many people to imagine that improvement in telegraphy has ceased, at least in this country. It has been publicly stated by very high authorities that, since the transfer of the telegraphs to the State, invention in that art has left the shores of the United Kingdom and flown to those of America. Moreover, it has been intimated that the monopoly in telegraphy possessed by the State has checked improvement.

Such statements are made in ignorance of the facts. Greater improvements have been made in telegraphy during the past eight years than in any previous period of similar duration. Inventions have, it is true, found their way from America; but they have also travelled in the opposite direction, and have taken root there. Indeed, improvement in telegraphy was never more active in England than it has been since the Government has managed the business.

The object of this paper is to prove the above propositions.

In order to approach these large questions with some degree of method, I will preface my remarks with a few definitions:—

1. Any combination of signals expressed—
(*a.*) By words;
(*b.*) By the elements of written language; or,
(*c.*) By preconcerted symbols
conveying an idea,—is a message.

2. Electric telegraphy is the art of conveying such messages to places beyond the reach of the ear or the eye by means of electricity.

3. Currents of electricity can be produced by chemical action, by motion in a magnetic field, by heat, and by the conversion of other forms of energy into the electrical form. They can produce signals by means of magnetic, thermic, or chemical effects.

4. Electric signals can appeal to the consciousness through any one of the senses, but in practice they utilise only those of sight and of hearing. Hence we have visual telegraphy and acoustic telegraphy.

5. They can be conveyed to distant places by means of conductors and insulators, which can be influenced by machinery or by human agency. Hand transmission is called key telegraphy, mechanical transmission is called automatic telegraphy, verbal telegraphy is called telephony.

6. The speed at which messages can be sent is regulated by the number of currents required to form each signal, and by the rate at which the successive currents of electricity which determine the signal can be sent. Hence we have ordinary and fast-speed telegraphy.

7. The capacity of the wire for the transmission of messages is also regulated by the number which can be simultaneously transmitted. Hence we have multiplex telegraphy.

Taking the improvements that have been made in telegraphs generally during recent periods, I will first of all deal with the receiving apparatus—the apparatus that translates to the mind through the eye or ear the messages sent. The general feature of the apparatus used in Europe was eight years ago dependent on sight, while in America it was dependent on sound. In England we had (1) the needle instrument of Cooke and Wheatstone, which was and is still universally employed on our railways. The vibrations of a little needle form the elements of written language, so that messages are spelt out letter by letter; (2) the Morse recording instrument, which indicates the signals by the combination of dots and dashes, marked or embossed on paper, and which is still the most generally used instrument throughout Continental Europe; (3) the Hughes type printer, which prints its messages on strips of paper in bold Roman letters; (4) the A B C or alphabetical instrument of Wheatstone; and (5) the bell instrument of Bright, which indicates the signals by the combination of the sounds of two different-toned bells.

In America, though the type printer has been very largely used, the principal instrument for many years past has been the sounder, which conveys dots and dashes to the mind of the operator by the varying duration of the sounds.

The gradual exercise of that law of evolution—the survival of the fittest—is in England slowly replacing the Morse recorder by the more simple sounder. It has removed the type printer excepting in connection with cables to the Continent. It has commenced to supplant the needles, which appeal to the eye, by a method which appeals to the ears, in fact, a modified form of the bell instrument, and its general tendency is to reduce all apparatus to one stage of uniformity. Acoustic apparatus has proved itself to be more simple, more accurate, and more expeditious than visual apparatus, but its capacity is limited to the rate at which the ear can comprehend signals. Again, the speed is limited by that at which the hand can send and write, and the operations of sending and writing must be simultaneous, while recorded messages can wait, or they can be distributed among several writers. Hence all apparatus fixed on fast-speed circuits must necessarily remain visual, while all other ordinary apparatus will probably be acoustic.

The principal improvements that have been recently introduced in receiving apparatus have been S. A. Varley's and Spagnoletti's induced needles, to remedy the disturbances due to atmospheric electricity; Siemens' direct ink-writer, to remedy the irksomeness to the eye of the embossed paper of Morse; Sir W. Thomson's syphon recorder, and Varley's Condenser, both of these being designed for expediting the rate of working through long submarine cables; Bain's chemical recorder (reproduced after many years interment) for expediting the speed of automatic working through long circuits; Neale's acoustic coil for assimilating the single needle and bell systems; Bell's telephone, which, however, is at present employed only on a limited scale in England.

With respect to sources of electricity. Innumerable improvements made have been made in batteries, but two only need be named, which, for power, efficiency, and economy, far surpass all others, and are being very considerably employed in the United Kingdom, viz.:—

Leclanché's, where ammonic chloride and manganic peroxide are the principal exciting agents, and Fuller's, where Poggendorff's potassic bichromate solution is the exciting agent.

These two batteries are gradually replacing with great economy the Daniell form, hitherto so largely used.

In sources dependent upon motion in a magnetic field, such as Wild's, Siemens', and Gramme's machines, so largely used for light and electrolytic purposes, though experiments have been made, they have not yet shown themselves equal in efficiency to batteries for telegraphic purposes.

It seems, however, very desirable that so simple a form of energy as the motion of a steam-engine or a turbine should be utilised as an electric machine, since probably it is the most economical form by which the necessary conversion can be made. In batteries the waste of energy is enormous.

In sources dependent on the conversion of heat into electricity, Clamond's thermo-electric pile, both in its original form and as modified by Leonard Wray, has been extensively experimented upon, but without any decided result. It is, however, worthy of record that for many weeks 43 circuits were maintained in working

* Paper read before Section G of British Association, Dublin, 1878.

order by one pile, in which the energy of gas jets was converted into currents of electricity.

It is, perhaps, in improvements in conductors that England has shone most. She has supplied the world with cables. Her iron-clad ropes rest on the bottom of every sea and her cable fleet is seen nearly everywhere. The Post-office alone possesses sixty-two cables, embracing 1,060 miles. The broad Atlantic is spanned by six cables, two of which are, however, dead and irrecoverable. This is due to defective design, and not to any inherent difficulty in ocean telegraphy.

In the manufacture of iron wire England stands pre-eminent. Messrs. Johnson, of Manchester, have led the way with their continuous "rolling" method.

Our moist climate, smoky atmosphere, winter fogs, and salt-sprayed land have proved a sad source of trouble in insulating our wires. The inventive faculties have been directed to surmount these difficulties of our climate more than to overcome any other source of trouble. Messrs. Clarke, Varley, Andrews, and many others have battled against these difficulties in vain. Several improvements are now under trial, such as Cordeaux's, to facilitate cleaning, Fuller's to increase resistance, and Messrs. Johnson and Phillips, who have struck out quite a new line by inserting a section of oil in the path of the current. Indeed, we are always experimenting in this direction. The higher classed apparatus that is being introduced needs higher classed insulation. The difficulties of this country are not experienced elsewhere, and therefore our efforts to cure the evil are not appreciated. The form that is found perfect in America failed miserably in England, and those accepted on the Continent are not to be compared to those in use here, when erected under similar conditions.

It is, perhaps, in the sending department that the greatest changes have been made.

Varley's double-current system, working with polarised relays, has survived all others; but the keys used in working it, which at first were cumbrous, have been revolutionised by Mr. Stroh, and by the Post-office electricians. Keys manipulated by hand cannot be made to send more than 45 words per minute, whereas the limit of recorders far exceeds this. Moreover, the hand soon tires, and cannot maintain the speed. Indeed, the average rate of sending of the best operator does not exceed 30 words a minute.

Alexander Bain, in 1843, proposed to replace hand-keying by automatic sending, and thus to attain much higher speed.

The ordinary dot and dash of the Morse alphabet was mechanically "punched" out of paper slips, and the paper thus punched automatically used to send the currents. The punched paper was mechanically drawn, at any speed, between a metal roller and "style," which came into contact at every opening, and thus completed the circuit and sent the signals. But Bain was before his time. Fast speed telegraphy was not then wanted. To be practically successful, invention and necessity must exist together. The old proverb quaintly expresses the idea, "Necessity is the mother of invention," but the child is often born before its mother. This was the case with Bain. There was not business enough to fill a wire, hence the system remained in abeyance. It was taken up again by Wheatstone, in 1868, when the necessity for improved methods began to be evident. Wheatstone devised a different system of punching, based on the principle of the Jacquard loom. This system has been very extensively employed by the Post-office. At the present moment there are over 170 instruments worked. Indeed, without its aid, it would have been impossible to have coped with the enormous amount of news which the cheap tariff thrust on the Post-office wires.

Wheatstone's well-known A B C apparatus has also been entirely remodelled and improved by the Post-office electricians. Nothing but the original idea remains, and the machine now turned out by Mr. Stroh is one of the most perfect pieces of mechanism employed in any art.

The telephone bids fair some day to be of use in some branches of telegraphy, but its progress has been disappointingly small. Everyone has been experimenting upon it. Scores of improvements have been suggested or patented, but it seems to have sprung into existence with all its perfections and imperfections on its head.

In fact, of all the instruments that I have seen and tried, those which I brought over from America last year and exhibited before this Association in Plymouth remain the best, and surpass all rivals. It has not at present found much favour in England. Its effects are feeble. It is too sensitive for practical use on existing lines. It requires complete quietude not only in the air about it, but in the wires conveying its signals, and its employment has been checked by the outrageous terms demanded.

The changes and improvements that have been made in the sending apparatus have been accompanied by equal improvements in the speed of working in the receiving apparatus. The laws of induction on wires and in instruments, the causes of retardation in working on long lines and submarine cables, have been carefully studied by English electricians, and means have been devised to reduce or remove the deteriorating influences. While on a short line it is possible to attain 1,000 words a minute, or more, the rate of working rapidly diminishes with distance, and between London and Dublin it was difficult to maintain more than seventy words a minute. Modes of compensating upon the line the currents sent by the Wheatstone transmitter, and of connecting up coils so as to eliminate the effects of currents induced in them from the instruments, have been successfully introduced by the Post-office electricians, so as to increase to the rate of working on long lines very considerably; and very recently relays of exquisite manufacture have been constructed which, inserted as translating relays or repeaters at intermediate points, have increased the rate of working between London and Dublin fifty per cent. Indeed, while the question of increased telegraphic communication between Ireland and England was under consideration, this more rapid mode of working solved the question. It has in some instances increased the rate of working 100 per cent.

Bain's original chemical recorder has been resuscitated, but its use is attended with disadvantages which have not led to its extended employment. It is in use in Dublin.

Bain's recorder has also been resuscitated in America. Mr. Little applied to it a condenser as a shunt to prevent the confusion or running together of signals, due to induction on the line when running at high speed. He called it "an overflow dam." Mr. Edison effected the same thing in a better way by using an adjustable electro-magnet as a shunt. Immense speed was attained by this means.

It will thus be seen that the distinguishing feature that has characterised the improvements made by the Post-office officials has been in the direction of fast-speed telegraphy; and it is not too much to say that they have more than quadrupled the working speed of wires.

The improvements made towards increasing the capacity of wires is wonderful. Where one message only is sent on one wire, in one direction, it is called *simplex* telegraphy.

Gintl, in 1853, showed how it was possible to send two messages, in *opposite* directions, on the same wire at the same time, and therefore rendered possible *duplex* telegraphy. He balanced the currents passing through the home station, so that equilibrium was only disturbed when the sending station was working at the same time, and then the disturbance exactly coincided in amount with the current which would have arrived to indicate the signals from the distant station. So that, whether

the home station were working or not, its apparatus continued to indicate the signals received from the distant station. Gintl's plan was considerably modified in 1854 by Siemens, Frischen, Edlund, and others, but for nearly 18 years it remained a scientific novelty, principally because the invention was before the necessity. It was not wanted in 1855. But it was also deficient in one respect. Mr. J. B. Stearns, in America, removed this defect in 1872 by applying a condenser to compensate for the effects of induction on the line, which were not understood in Gintl's day, and duplex telegraphy became a practical system.

There are now in England nearly 200 circuits so worked, and our ocean cables, by the aid of peculiar condensers, introduced by Muirhead and Taylor, are gradually being duplexed.

Bernstein, Stark, Siemens, Kramer, and Bosscha, in 1855, showed how two messages could be sent in the *same* direction at the same time, on the same wire, and hence rendered possible *diplex* telegraphy.

The principle of this system of working consists in having two apparatus, the one worked by weak currents and the other worked by strong currents, and so arranged that they work independently of each other; but the plan has never been brought into actual practical use as a *diplex* system. When, however, these two plans were combined together, they formed *quadruplex* telegraphy.

This combination was suggested by Bosscha and Stark, in 1855, and by Mr. Oliver Heaviside, in 1873. It was patented in this country by Mr. Stearns, in 1874. It was, however, for the first time put into practical operation by Messrs. Edison and Gerritt Smith, in 1876, upon the lines of the Western Union Telegraph Company, in America, where it is now applied to sixty circuits. It is now being introduced by the Post-office.

Its method consists in working one apparatus with reverse currents, independent of their strength, and the other apparatus with strong currents independent of their direction, both being duplexed. Hence it is in fact a double duplex system. It works perfectly on short lines, but it becomes troublesome on long lengths.

It is capable of considerable extension and variation. In America it works to distances exceeding 1,000 miles by means of relays or repeaters fixed about the centre of the circuit. Thus New York works to St. Louis with relays in at Pittsburg. At the present time, West Hartlepool and Middlesborough are each working duplex to London—on separate wires to Leeds, but on the same wire to London.

Telephone currents are very minute currents following each other with great rapidity, and they can be superposed on ordinary working currents without interfering with their action on ordinary telegraphic apparatus. Mr. Cromwell Varley utilised this principle in 1870, by patenting what we may call *harmonic* telegraphy, but it remained for Mr. Elisha Gray, of Chicago, to work the system out practically. He utilises the wires employed for serving "way" or intermediate stations by working them also harmonically between their terminal points, thus vastly increasing their capacity. This system is now under trial in America, and it is exhibited in the Paris Exhibition, where Mr. Gray is also showing an *octoplex* system, or a mode of sending eight messages on the same wire at the same time, which is said to have been experimentally tried with success between New York and Philadelphia.

Other systems for increasing the capacity of wires have also been devised on the Continent. Thus Meyer (whose instrument was exhibited at the Vienna Exhibition of 1873, and is now in use on a small scale in France and Austria) sends four messages in the same direction apparently at the same time; but they are not sent simultaneously, the signals are divided and distributed so as to obtain the maximum carrying capacity of the wire, and, therefore, the practical gain is not great.

M. Baudot, whose apparatus is exhibited at the Paris Exhibition, sends five messages upon the Hughes apparatus in the same direction, but they also are not simultaneous, and though, by utilising the intervals of time occupied by the type wheel in revolving and distributing the signals, he increases the capacity of the wire, the gain is not very different. The instrument is very complicated, and its practical success questionable.

The French Government is also trying an automatic system of type printing, devised by M. Olsen, which is said to increase the capacity of the Hughes type printer 33 per cent.

Now of all these systems, the most valuable, successful, and practical are the Wheatstone automatic and the quadruplex The average speed attained on the automatic, on an average circuit worked simplex, is 100 words per minute, which becomes 200 words per minute when worked duplex. The average speed attained on the quadruplex is 120 words per minute. Hence, when duplexed, automatic is more capacious than the quadruplex, but the elasticity of the quadruplex makes it a valuable help to the automatic system, and when the two are combined (which has recently been done by the electricians of the Post-office) the advantages of both are secured.

But it must be remembered that each system has its disadvantages—principlly the employment of a more highly trained staff. The automatic system involves previous preparation, and therefore preliminary delay. The complication and delicacy of both systems involve better-maintained lines, and their failure tends to much greater trouble. It is not advisable to trust all one's eggs to one basket. There is a distance within which each become disadvantageous and expensive, and where it is cheaper and better to erect extra wires.

Now these systems of fast-speed and multiplex telegraphy have grown up in England under the fostering care of the Post-office since the transfer of the telegraphs to the State; and, therefore, I contend that I am justified in saying that greater improvements have been made in telegraphy during the past eight years than in any previous period of similar duration.

Necessity drove the Americans to the introduction of quadruplex telegraphy, as it drove us to the employment of the automatic system. The increased business demanded increased capacity of wires. Automatic telegraphy in America was in the hands of opponents. All the skill of the Western Union Telegraph Company was devoted to the improvement of multiplex telegraphy, and the quadruplex is the result. Neither duplex nor quadruplex telegraphy were, however, invented in America. They were imported there, but in a very crude condition. The great practical skill and ingenuity of our cousins made them what they are—the most valuable adjuncts to telegraphy.

It will be observed that in the above enumeration England stands prominent as the home of the inventor. While she can boast of Wheatstone, Cooke, Bain, Thompson, Clark, Varley, Fuller, &c., and Europe can boast of Gintl, Siemens, Frischen, Meyer, &c., America has her Morse, Hughes, Stearns, Edison, and Gray.

In 1868 the Western Union Telegraph Company, feeling that their telegraphic system was not up to the requirements of the age, secured the valuable services of Mr. Cromwell Varley, who educated them up to the European standard of electrical knowledge, and they have certainly bettered their instruction.

America has freely adopted our system of pneumatic telegraphy. They have introduced our methods of testing. They have adopted Johnson's method of manufacturing iron wire. They have introduced on some lines automatic telegraphy, modified by Messrs. Little and Edison. They are trying our superior batteries.

Hence while we have not been slow to avail ourselves of their advances, they have equally availed themselves of our progress.

Telegraphy is thus cosmopolitan. Whatever of value and advance is produced in one nation is adopted by all. Invention has not left the shores of England. The English Telegraph Department stands in the first rank. Foreign Governments freely avail themselves of our experience. Our models, our plans, and our manufactures are found in every clime.

It remains for me to say a few words as to the part played by the Post-office in fostering these advances. The system of new wires is unique in its kind. Forty-seven new circuits and twenty-two special wires are made up every day for the transmission of intelligence. News is transmitted direct from London to every town at which a daily paper is published. There is thus scarcely a town in the country were every man has not on his breakfast table a morning paper containing the debates of Parliament of the previous night.

This is maintained by the the automatic system. Half a million words are frequently sent in one night from London alone. When Lord Beaconsfield gave his address in the House of Lords on the results of the Berlin Congress, 526,250 were transmitted from "T.S.," the central station.

There is not a branch of the service that has not been improved. New batteries, new insulators, preserved poles, improved wires, the most perfect relays, and multiplex apparatus have all found their way into the Post-office service. In 1873, 15,535,780 messages were transmitted over 105,285 miles of wire, being an average of 147 messages per mile of wire, while in 1878, 22,171,783 were sent over 113,333 miles of wire, being an average of 200 messages per mile of wire. Of the 8,000 miles of additional wire which have been put up, more than one-half is for private purposes; therefore the message average is really even higher than that given. Indeed, only 4,000 miles wire have been erected to transmit nearly 7,000,000 messages, or an increase of nearly 50 per cent. of work.

No one has ever been heard to complain of the action of the Post-office in adopting improvements, but, perhaps, some disappointed inventor. It must be remembered that improvement is invariably the result of inventive power combined with practical experience well tempered with theoretical knowledge. Practical inventions rarely emanate from without. The long list that I have enumerated is, without exception, composed of men who have possessed these qualifications; but the great majority of patents are taken out by those who do not possess them at all. They are the most troublesome men to deal with. They cannot be convinced of their errors, and their want of experience prevents them from seeing their failure; but of the numerous patents that are annually taken out, how many complaints are made by those who have not been fairly and properly treated? The following table gives a list of patents which have been taken out for improvements in telegraphy for each year since 1862. (See next column.)

IMPROVEMENTS IN TELEGRAPHY.

Year.	1.	2.	3.	4.	Total.	
1862	29	9	7	6	51	
1863	13	7	8	3	31	
1864	24	3	3	3	33	
1865	24	27	8	7	66	
1866	25	13	7	9	54	
1867	39	7	4	4	54	
1868	31	5	6	7	49	
1869	28	11	3	6	48	Average. $48\frac{1}{4}$
1870	26	5	4	4	39	
1871	17	3	4	10	34	
1872	50	5	3	4	62	
1873	49	5	2	6	62	
1874	50	13	2	2	67	
1875	25	12	2	2	41	
1876	35	25	3	3	66	
1877	42	3	—	1	46	Average. $52\frac{1}{8}$

NOTE.—Column 1 contains the number of patents which refer exclusively to land lines. Column 2 those which refer exclusively to submarine work. Column 3 gives the patents which refer to the manufacture of telegraph material. Column 4 gives those patents which bear partially upon telegraphy, and partly on other arrangements to which such inventions are also applicable.

They are thus now as numerous as ever, indeed, the average of the last eight years exceeds that of the previous eight; hence I am justified in saying that the possession of the telegraphs by the State has not checked improvement. Moreover, the telegraph system outside that of the Government is as great now as the whole telegraph system of the country was before the transfer; and inventors, if they are dissatisfied with the Government, have the numerous cable companies and the great railway systems of this country to fall back upon. Private enterprise is not dead.

The fact remains that telegraphy, whether for commercial or railway purposes, is more highly developed in England than in any other country, not excepting America, and this development is due as much to the action of the State in purchasing and managing the commercial system of the country as to the competition that remains between nation and nation and between company and company. The lines of the Post-office are now worked with a view to a fair commercial profit as much as any private concern. The action of the Government in all departments is jealously watched by its master, the public. This master is not always just nor generous. Its prerogative is to find fault with the Government in all that it does, and it is well that this right be exercised, for it forms a very valuable check on abuse, it strengthens discipline, and it secures a worthy discharge of duty.

I can speak from the experience of a commercial and of a Governmental department extending over twenty-five years, and I have no hesitation whatever in asserting that there is as much zeal, energy, and enterprise in the one as there is in the other. The control of Parliament and of the press exercises a far more disciplinary and supervising power on the management of a Government Department than any half-yearly meeting of shareholders or occasional committee of investigation.

INDUSTRIES OF THE PROVINCE OF REGGIO, IN EMILIA.

Consul Colnaghi states that manufacturing industries, with few exceptions, have acquired no great development in the province of Reggio. The total number of persons obtaining a living under this head, including the lowest workmen, according to the census of 1861, was 27,285, or rather under 12 per cent. of the population. Of the five silk mills in operation, there are two, situate at Reggio and Scandiano respectively, which are provided with the latest mechanical improvements. In the sixteenth century 5,000 weavers found employment here, while 500 firms of drapers exported large quantities of silk stuff to France, Flanders, Germany, and more distant countries. The comparison of former prosperity with the present extinction of this industry, to which the silkworm diseases gave the final blow, is by no means satisfactory.

The principal and most ancient industry is cheese-making. The cheeses of Bibbiano are favourably known to the trade under the name of "Parmesan," and have obtained medals at both foreign and national exhibitions. The butter of Bibbiano is also excellent. The dairies,

in which cheese, butter, and ricotta are made, are commonly called "Caselli." The owners of large farms have each their own "Casello." Small proprietors either sell their milk to cheese-makers, or carry it twice a day to a dairy, the "Casaro" of which works it up, for their account, in conformity with the following rules:—Each customer is provided with a wooden tally corresponding to one kept by the "Casaro." The quantity of milk brought is notched on the two tallies superposed. The unity of the measure at present used for milk is 20 litres, which continues, as of old, to be called "secchia" (pail), the volume of which was nearly similar, but which was divided into eight "scodelloni" (pans.) To divide the produce among the different customers, a method is employed which, although it has been in use in the province for a long time, is probably adopted from the Swiss "Fruitièrès." When on a given day, the "Casaro" works up, say, 20 secchie of milk, the customer whose tally marks about that quantity, has the whole of that day's produce as his share. He takes away the butter and "ricotta," while the cheese remains at the dairy for the successive operations of salting and seasoning, until it is closed about the end of November, at which time, or a little later, the cheese is sold to wholesale dealers, to be kept and retailed at an after date.

In the manufacture of brushes from roots, which is carried on to a considerable extent, the root used is the *chrysopogon gryllus*. Formerly the raw material, sorted in lengths, made up into bales of one quintal each, worth 200 lire, was all exported to Paris; but within the last three years Mr. Gazzani has established a brush factory at Reggio, importing Chinese fibre in addition to using the local root. The roots are obtained from the lower part of this province, of that of Modena, and also from the Ferrarese. The finer qualities are met with in the water meadows. To prepare the roots, they have, first, to be well cleaned; this is done, for the rougher sorts, in an iron grating, for the finer, with a wooden round-toothed instrument. When all the dust and outside are taken off, the roots are steeped in sulphur, to give them a yellow colour, damped, and set up to dry. All qualities are made—scrubbing, washerwomen's, clothes brushes, &c. In 1873, a large number of washerwomen's brushes were sent to Piedmont and Liguria. Mr. Gazzani has a Government contract for supplying brushes to the Royal Carabinieri, and has also undertaken to furnish curry combs to the same force, obtaining the iron from Buscia. The preparation of leather forms likewise an important industry in the province; the native hides and skins not sufficing, the demand is supplied from Germany.

SILK PRODUCTION OF ITALY.

The Journal of Commerce and Agriculture, *Il Sole*, published at Milan, contains information respecting the yield of raw silk obtained throughout the different provinces of Italy, compiled annually by the Cavaliere Pasquale di Vecchi. The comparison is carried back to the period when the country was free from the pest of silkworm disease, which has occasioned such injurious effects upon this important industry, and has hitherto baffled the efforts of the growers.

The following figures indicate the variations experienced, and the per-centage rates of diminution have been likewise supplied by the same authority:—

	Kilogrammes.	Proportion per cent.
Yield before the disease	3,710,000	—
,, of 1863	2,308,000	38
,, ,, 1864	1,731,000	53
,, ,, 1865	1,762,000	52
,, ,, 1866	1,800,000	51
Yield of 1867	2,000,000	46
,, ,, 1868	1,900,000	49
,, ,, 1869	2,150,000	42
,, ,, 1870	3,180,000	14
,, ,, 1871	3,473,000	6
,, ,, 1872	3,125,000	16
,, ,, 1873	2,960,000	20
,, ,, 1874	3,430,000	7
,, ,, 1875	3,073,000	17
,, ,, 1876	1,010,000	72
,, ,, 1877	1,853,400	50

The yield of 1877 was distributed throughout Italy as follows:—

	Kilogrammes.
Piedmont, Liguria, and Sardinia	438,420
Lombardy	754,670
Parma and Piacenza	30,060
Modena, Reggio, and Massa	23,160
Romagna	33,000
Marches	42,380
Umbria	10,600
Tuscany	77,500
Neapolitan Provinces	63,000
Sicily, Calabria	46,000
Venetia, Frioli	271,235
Italian Tyrol	63,375
Total	1,853,400

The returns of the past year are considered thus far reassuring, since they are greatly in excess of the previous year, 1876, although they only show one-half of what should be considered an ordinary harvest.

GENERAL NOTES.

A New Fibre.—Small quantities of a new variety of fibre are received in England from time to time for which a great demand is likely to arise if its product on a sufficiently large scale can be relied upon. It is the produce of a variety of aloe said to be peculiar to Mauritius, or which, at any rate, grows in abundance in that island, and from the leaves of which long fibrous threads of peculiar tenacity and pliability are extracted. The leaves are simply crushed, and do not require to undergo the complicated processes necessary for preparing hemp and flax, so that the cost of labour is greatly reduced. Threads and ropes formed of these fibres are said to be superior to any known material of similar kind, and a line made from them will excel in toughness an iron wire of the same size. At the same time the suppleness is such as to obviate all the disadvantages attending the use of stiff metal wire. The parcels of the new fibre which have reached this country have been well reported on by competent judges, and the principal difficulty in the way of its extended use is the limited supply. With careful cultivation, it is probable that the growth of the aloe might be encouraged, and its introduction into other countries, the soil and climate of which are suitable for its production, would enlarge its at present limited area of growth. The aloe will grow in temperate as well as in hot climates, and is adapted for a dry soil. Many others of our colonies besides Mauritius, with its 730 square miles, might attempt its cultivation. One of the chief properties of the material is that it is believed to be free from the liability to rot which characterises all other fibres when exposed to the action of salt water. If this should prove to be the case, it would be invaluable for the manufacture of ships' rigging and for similar purposes.—*Colonies and India.*

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,345. Vol. XXVI.

FRIDAY, AUGUST 30, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

NATIONAL WATER SUPPLY.

HEALTH AND SEWAGE OF TOWNS.

The Reports of the Congresses on the above subjects have been published in pamphlet form, and each report can be obtained at the Society's House, price 2s.

PARIS EXHIBITION.—ARTISAN REPORTERS.

Up to the present time about 114 artisans have been sent over by the Joint Committee; some at the expense of the Fund, and others at the expense of their employers, or of their several localities. Others have been selected by the Committee, and will go out early in September. The City of Bristol is sending 10, the City of Edinburgh 12, Leeds six, representing various industries in those places. Dublin has arranged to send twenty-five connected with special trades of that city. Messrs. Thomas Peters and Sons are sending over three of their workmen at their own expense.

List of Subscribers.

	£	s.
Her Majesty's Commissioners	105	0
The Society of Arts	105	0
His Royal Highness the Prince of Wales, President of the Royal Commission	50	0
The Worshipful Company of Fishmongers	26	5
The Worshipful Company of Carpenters	10	10
The Earl Spencer, K.G.	26	5
The Worshipful Company of Salters	10	10
The Worshipful Company of Clothworkers	100	0
The Worshipful Company of Drapers	52	10
The Worshipful Company of Mercers	52	10
The Builders' Society	21	0
Mr. Samuel Morley, M.P.	50	0
The Worshipful Company of Cordwainers	26	5
The Worshipful Company of Haberdashers	21	0
A. H. Brown, M.P. (Messrs. Craven Dunnill and Co.)	10	0
Messrs. Eyre and Spottiswoode	5	0
Messrs. Gillows and Co.	5	0
Mr. E. F. Bodley, Burslem	5	0
Mr. A. H. Robertson (Wouldham Cement Company)	10	10
Messrs. Thos. Peters and Sons	10	10

TECHNOLOGICAL EXAMINATIONS, 1878.

The following candidates have obtained certificates in the examinations for the present year:—

The letters H., A., and E., represent the Honours, Advanced, and Elementary grades respectively, and the figures which follow denote the class in each grade. The numbers after the names show the ages of the candidates.

Alkali Manufacture.

Burrill, John, 21, Mission-hall, St. Helen's, E. 2
Davies, James W., 24, Widnes Sci. Class, E. 2
Farrant, Nathaniel, 22, Widnes Sci. Class, E. 2
Glover, Thomas, 21, Mission-hall, St. Helen's, A. 1
Hosker, Richard B., 20, Mission-hall, St. Helen's, E. 1
Jackson, John, 22, Widnes Sci. Class, E. 2
Knowles, John, 18, Widnes Sci. Class, E. 1
McCrossan, Joseph W., 22, Widnes Sci. Class, E. 2
Murphy, William F., 19, Widnes Sci. Class, E. 2
Tate, Francis H., 20, Widnes Sci. Class, A. 1, with the Prize of £7.
Taylor, James, 27, Widnes Sci. Class, E. 1, with the Prize of £5.
White, Joseph W., 16, Widnes Sci. Class, E. 2
Williamson, Joseph, 30, Widnes Sci. Class, A. 2

Carriage Building.

Mundy, George, 31, Grantham Sci. Class, E. 1, with the Prize of £5

Cotton Manufacture.

Bardsley, George W., 17, Bolton M.I., E. 2
Buckley, William H., 21, Oldham Sci. Sch., E. 2
Heywood, Tom, 22, Bolton Parish Church Sch., E. 2
Lees, John T., 21, Oldham Sci. Sch., E. 1, with the Prize of £5
Marcroft, John G., 17, Oldham Sci. Sch., E. 2
Mellor, Charles, 20, Oldham Sci. Sch., E. 2
Morris, John, 27, Bolton Parish Church Sch., E. 2.
Percival, Alban, 21, Bolton M.I., E. 2
Urmson, Samuel, 19, Oldham Sci. Sch., E. 2
Waite, James A., 20, Bolton Parish Church Sch., E. 2
Whitehead, James, 16, Oldham Sci. Sch., E. 2
Wood, George T., 21, Oldham Sci. Sch., E. 2
Worrall, John, 21, Oldham Sci. Sch., E. 2

Gas Manufacture.

Askew, Benjamin, 29, Wedgwood Inst., Burslem, E. 2
Blair, Thomas, 23, Birkbeck Inst., E. 1, with the Prize of £5
Dempster, John, 23, Halifax Mec. Hall., E. 1
Fligg, Mark, 23, Dewsbury M.I., E. 1
Glover, Samuel, 20, Mission-hall, St. Helen's, E. 1
Hobart, John W., 24, Batley Mental Improv. Soc., E. 2
Holgate, Thomas, 21, Burnley M.I., E. 2
Plant, Joseph, 34, Wolverton Sci. Sch., E. 2
Sheard, John T., 19, Batley Mental Improv. Soc., E. 1

Steel Manufacture.

Adnitt, Charles, 20, Crewe M.I., E. 2
Ambler, Frank, 15, Crewe M.I., E. 2
Andrew, Samuel, 18, Oldham Sci. Sch., E. 2
Bailey, John M., 22, Crewe M.I., E. 2
Beaumont, Tom, 20, Crewe M.I., E. 2
Bell, Charles W., 20, Crewe M.I., E. 1
Beresford, Charles, 21, Crewe M.I., E. 2
Chester, Arthur H., 21, Crewe M.I., E. 1
Cliff, Alfred, 18, Crewe M.I., E. 2
Cotton, Albert, 19, Crewe M.I., E. 2
Davison, A. W., 17, Crewe M.I., E. 2
Davison, John, 16, Crewe M.I., E. 2
Dean, James A., 22, Crewe M.I., E. 2
Dobson, Stephen, 35, S. Kensington, H. 1, with the Prize of £10

Duckworth, Thomas, 21, Liverpool Sci. Sch., E. 1, with the Prize of £5
Dunkerley, John, 22, Oldham Sci. Sch., E. 1
Dyer, Joseph, 20, Crewe M.I., E. 1
Eaton, George, 25, Crewe M.I., E. 2
Geddes, John W., 19, Oldham Sci. Sch., A. 1, with Prize of £7
Grant, Robert, 21, Crewe M.I., E. 1
Groves, William, 20, Royal Coll. of Sci., Dublin, E. 1
Harris, Sydney J., 20, Manchester M.I., A. 1
Harrison, George, 19, Oldham Sci. Sch., E. 1
Hayes, Thomas, 27, Oldham Sci. Sch., E. 1
Holland, George, 22, Crewe M.I., E. 1
Holmes, Thomas, 39, Crewe M.I., E. 1
Laird, William D., 21, Crewe M.I., E. 1
Lambert John M., 19, Crewe M.I., E. 2
Latham, William B., 25, Crewe M.I., E. 1
Loader, James, 21, Crewe M.I., E. 1
Low, David A., 21, Manchester M.I., E. 1
Mackay, Alexander, 21, Crewe M.I., E. 1
Manion, John, 24, Oldham Sci. Sch., E. 2
Mann, James, 21, Crewe M.I., E. 1
Martin, Horace C., 20, Crewe M.I., E. 1
Morgan, Thomas H., 21, Crewe M.I., E. 2
Needham, Joseph E., 21, Oldham Sci. Sch., A. 1
Ogden, Fred, 19, Oldham Sci. Sch., A. 1
Outon, Charles B., 18, Stratford M.I., E. 1
Palmer, Alfred, 20, Crewe M.I., E. 1
Phelan, James, 27, Crewe M.I., E. 2
Phelan, William, 26, Crewe M.I., E. 1
Platt, Travis, 18, Oldham Sci. Sch., E. 1
Power, Thomas, 17, Crewe M.I., E. 1
Routledge, William E., 20, Crewe M.I., E. 1
Sackfield, Thomas E., 19, Crewe M.I., E. 1
Savage, Henry, 22, Crewe M.I., E. 2
Savage, William, 19, Crewe M.I., E. 1
Spencer, William, 20, Oldham Sci. Sch., E. 1
Webster, Charles, 17, Crewe M.I., E. 1
Wild, Arthur E., 17, Crewe M.I., E. 1
Worthington, Edgar, 22, Crewe M.I., E. 1

Telegraphy.

Elliott, Joseph W., 39, Avenham Inst., Preston, E. 1, with the Prize of £5

Wool Dyeing.

Dyson, Henry, 21, Halifax M.I., E. 1, with the Prize of £5

The following candidates have passed in their Technological subjects, but not having gained the required successes in the Examinations of the Science and Art Department, have not obtained Certificates:—

Carriage Building.

Mercer, John H., Oldham

Cotton Manufacture.

Broadbent, James C., Oldham
Kearsley, Alfred, Oldham
Mattinson, John, Randalstown, Antrim

Gas Manufacture.

Akroyd, Benjamin, Halifax
Haddock, William S., Widnes
Hepworth, R. A., Glasgow

Steel Manufacture.

Beresford S., Crewe
Bodden, William, Oldham
Broomer, W., Crewe
Chadderton, Frank W., Oldham
Cowan, C., Crewe
Eaton, J., Crewe
Edleston, J., Crewe
Edwards, J. H., Crewe
Egerton, J., Crewe
Greensmith, T. W., Crewe
Harvey, C. L., Crewe
Hobson, F., Crewe
Hughes, C., Crewe
Hughes, H., Crewe
Hughes, W. H., Crewe
Jackson, G. F., Crewe
Kenworthy, Orlando, Oldham
Latham, R. H., Crewe
Lawton, J. Crewe
Milner, Henry, Oldham
Mottershead, Francis W., Manchester
Nevitt, H., Crewe
Nichols, T., Crewe
Osborne, W., Crewe
Platt, Joseph, Oldham
Pottie, G., Crewe
Riley, W., Crewe
Robinson, Robert M., Oldham
Sleight, J., Crewe
Stubbs, J., Crewe
Turner, A. M., Crewe
Wadsworth, W. H., Crewe
White, J., Crewe
Wilson, T., Crewe

Telegraphy.

Badrick, T., London
Emmott, Walter, Halifax
Morgan, Francis, London
Pink, Ernest G., London
Powell, L. W., London

Wool Dyeing.

Aldred, James, Oldham
Davis, Frank, Greetland
Wadsworth, Clarence, Oldham

UNIVERSAL CATALOGUE OF PRINTED BOOKS.

(*Continued from page* 860.)

The following is a continuation of the evidence taken before the Committee on this subject*:—

128. **Edward Arber, F.S.A., &c.**—I have already pledged myself to do half the work. I have included all the books from 1554 to 1640, then I undertake to import them in the "Transcript of the Stationers' Company's Registers," which, however, will be limited only to 230 copies.

129. **The Chairman**—I must keep you in order; the object to-day is to obtain information upon certain points. We cannot go into the question of the plan which you adopt of printing a certain catalogue; we do not want the number to be printed, and all that.—Would you like, then, the way in which I propose to print this catalogue as a finalty, and for your guidance and information?

130. **The Chairman**—We will not enter into that at all; we think we should have any information you can give us; but you cannot go, in the present state of the inquiry, into the plan that you adopt.

131. **Mr. Bullen**—It would not be of any importance to the object that you have in your view, but Mr. Arber's special knowledge on the subject would assist you considerably.

132. **The Chairman**—We admit that the only question is whether to-day is the time to go into the details. Mr. Arber's experience and the knowledge of the cost will assist us in the estimate which we form. I hope Mr.

* See *Journal*, February 15th, 1878.

Arber will think that we are keeping this inquiry to-day within the limits that we assigned to it.

133. **Mr. Arber**—A large portion of the work down to 1640 has been already done upon a more systematic plan than that of the specimens submitted. It is more final, more correct, and more voluminous than that; that is what I want to say. I do not think the Committee, who are acting under the Prince of Wales, know it, and I think it right you should know it. I have all printed books—not only English—and if you will allow me I will give you in five minutes an answer which you may consider as sufficient for the information of his Royal Highness the Prince of Wales. I will not stop at 1600; I will give you an answer that can take it down to 1660. The Prince of Wales has asked for the cost of the catalogue of all English books printed in England down to 1600. The answer to that may be made on this method—that the outside ultimate cost of the printed catalogue (I mean printed on both sides) down to 1660 is £20,000; that it might be published at about ten guineas the set; that it would take ten years to accomplish; and that, if well done, there is every probability of the first cost being repaid.

134. What is your own experience upon the publication?—I believe, sir, that as regards the printing of such a catalogue there is no man who has got the same experience as I have upon that point, because this transcript, &c., has been done entirely by me at my own risk and expense. I repeat again that the outside first cost of printing a catalogue of all printed English books down to 1660, would be £20,000, that it could be sold in sets not exceeding ten guineas a set, that it would take ten years to do, and that if well done—I lay great stress on that because I am seeking now to satisfy librarians—but if well done it would repay its expense. That is the sum total of my opinion. I am not allowed, at this point, to open my mouth as to the mode in which it is to be done. I may also mention that the number of titles in that period may be roughly taken at 60,000, whereof 30,000 will be between 1640 and 1660, and the other 30,000 will be from the time of Caxton down to 1640. The 30,000 in the time of the Commonwealth, that is from 1640 to 1660, include all works and pamphlets. What I wanted to say is, that down to 1660, for £20,000, a catalogue can be produced which can supply all the requirements of the librarians, the scholars, and the second-hand booksellers; and the fear that was expressed when I first heard of this thing, which I did at a shop, that the work would not be properly done, that is to say, you would get a mere transcript of the title of the book, such as this specimen is. The mere fact of printing it on one side is useless.

135. **Sir H. Cole**—Have you counted the titles in your transcript?—About 20,000.

136. That extends to 1640?—1640.

137. About 20,000. What does "about" mean?—It means about. I cannot say. I have not counted them yet. I have no motive for counting them. As near as I can say.

138. **The Chairman**—You said about 4,200 pages?—2,800 pages; about eight to a page.

139. **Mr. Bullen**—I think Mr. Arber's observation is most valuable, if he were invited to put it in writing.

140. **Mr. Arber**—I happen to know this. I do not know much about the later literature. My own special knowledge goes from the time of Caxton to the time of Anne. The difficulty is very large indeed, and for a special catalogue—an exhaustive catalogue—you require a scholar at the head, and a man perfectly conversant with that period of literature. Now, allow me to mention Mr. Ellis, of New Bond-street. You ought to ask Mr. Ellis to give evidence. He is specially well up in that early period. Still, for a general outline of the time, I consider I know, through what I have had to do with that transcript, about as much as most people.

141. **The Chairman**—I am sure we are much obliged to Mr. Arber for the information so far.

[Mr. Arber's examination closed.]

Mr. G. Bullen, Keeper of the Printed Books, British Museum, examined:—

142. **Mr. Bullen**—I shall first of all say, Mr. Chairman, I think it is my duty to tell you that the question of printing is a question now practically before the trustees of the British Museum.

143. **The Chairman**—Now?—Now.

144. **The Chairman**—Have you fixed any period?—The English books down to the year 1640.

145. **Sir H. Cole**—That is a valuable piece of information.

146. The reason that 1640 is mentioned is because it is a somewhat definite period, which will exclude the large mass of controversial tracts that began to be issued about that time.

147. **The Chairman**—I think the committee will feel that is a most gratifying piece of information?—I do not mention that as by any means precluding such a work as this, because that, of course, would only include the books in the British Museum; as Mr. Arber is well aware, and he will inform you, there are numerous others which would enter into your scheme; you would get your titles of books from all quarters.

148. If the British Museum contemplated doing it, and the public money pays for it, the work to a very great extent is already done, because it is obvious that that being done within a reasonable time—I do not know what would be a reasonable time—if it were done, and it was thought expedient to go on with this universal plan, this becomes a very little matter by comparison?—I do not know that it can be said to be finally resolved. It has been seriously contemplated.

149. That is an inquiry as to cost?—I should not be in a position at once to undertake it, and I should have to make my arrangements officially for the suitable revision, and so on.

150. Then, in your opinion, how long would it take?—I think, from the commencement of printing, that it might be done—from the moment that we should go to press, I think it would be done in less than two years.

151. Can you mention how many titles?—I have not a sufficiently clear notion. I think, with titles and cross-references altogether, it would amount to about 25,000, or perhaps more.

152. That agrees somewhat with Mr. Arber's view; his notion is that it would be about 30,000?—My plan would include cross-references; they are very numerous.

153. **Mr. Arber**—It agrees with my view on the understanding that the British Museum has not got a third of the books of that time in it.

154. **Mr. Youl**—About 60,000 titles, I think you said.

155. **Mr. Arber**—I said that they may be taken at 30,000, all books printed in England, or by Englishmen abroad, or by or for Englishmen abroad; and that is my judgment. Of course, the British Museum are very strong in some places, and they are very weak in other, and some of the best books they have not got at all; that confirms Mr. Bullen's estimate, that it would be about 25,000, roughly.

156. **Sir H. Cole**—Upon the point now bearing upon our proceedings, should you say if it would take two years?

157. **Mr. Bullen**—I really think I might say two years.

158. **The Chairman**—That is your estimate, in fact?—Yes.

159. **Sir H. Cole**—You have got the titles already done? —They are already done, but require revision in many respects. This would be a boon to literature, not merely as a catalogue—and, therefore, I think many things would still require to be done to the titles—as, for instance, when the titles were originally written the names of the printers and publishers were not always given, except from the very early times, such as Caxton, and such persons. When we come to about 1600, the names of the printers and publishers were not always given, although I submit that for a good catalogue it is essential; then we should find them corresponding with Mr. Arber's index there as they were endorsed on the cover.

160. Therefore the titles being ready, you think the alterations and revisions would eke it out to two years?—I said from the commencement of the printing of the catalogue, because I should not urge forward such a catalogue, as it is not absolutely needed; we have all the books in our general catalogue at the museum available for the purpose; this would be an important catalogue for booksellers and libraries.

161. Do you consider it would not supersede this idea? —I think not; it would be more exclusive in one way and less exclusive in another.

162. Do not you think that if the country is going to assist the trustees to do the work that you contemplate, and assuming that to be half done, that it would be a right thing to do the other half?—I do not know, the trustees may consider that they have quite enough to do to take care of their own library.

163. The British Museum is the great head-centre of the libraries, it is a great national affair; it is important for it to know, certainly, what it has got, but it may not have something which it may desire to have, and therefore this catalogue will be a very imperfect thing. That is, assuming that half remains to be done, and that it is printed up to a given day, and that you can get the books there two days afterwards. It would be like the present system of the British Museum, that it never can be complete?—That is the case with every catalogue.

164. Not with this, if it is done properly?—This will be one thing, that need not clash with the other; you see, the scheme of the trustees embraces a greater number of years, and your scheme embraces a greater number of books.

165. I should like to ask you whether you would not assign a great value to having the thing as perfect as you could at a given time; or to wait and put other books into it besides the books that you have?—It might be desirable from your point of view; I should not advocate it.

166. **Mr. Arber**—Regarding this practical catalogue of the 5,000,000, it is to be, so far as I know, an absolute catalogue of all the books that I have got out of the different libraries. I have hundreds of books that are not in the Museum and not in the Bodleian Library. It would include all manner of books printed abroad; and, so far as I can make it, that is an attempt at a universal catalogue, done on scientific principles. In the transcript there, you have got the titles of all the books. Of course, there is the record of all the books and all the works—I get, from what I have seen—but nothing will go in my 5,000,000 but what I have absolutely seen.

167. **Mr. Bullen**—Will you allow me also to mention that there is in progress now a most valuable catalogue, namely, that of the library of Mr. Huth, compiled by Mr. Ellis. I believe it is about half done. That would be of wonderful assistance, if you could wait in your performance of this projected catalogue, or, at all events, not proceed at present until you have the advantage of that. There is another; that of the Brittwell Library, belonging to Mr. Christie Miller, of which Mr. Graves is making a catalogue.

168. **Mr. Arber**—It cannot be seen.

169. **Sir H. Cole**—Is it your opinion that, if the universal scheme becomes a possible intention, the British Museum collection should form the basis?—That is my opinion.

170. For instance, suppose the trustees rejected the idea of doing that for all literature; in your view, the first thing to be done, in order to get the Universal Catalogue done, would be to go to the British Museum and copy or print the 1,500,000 titles?—To print that catalogue, as I said before to Mr. Foster, and as I have always expressed my opinion, would be the best method, and I believe the only sure method, of laying a solid foundation for a universal catalogue.

171. To print all that you have got?—From 1450 up to the present time.

172. I should like to ask you, are there a million and a quarter titles?—More.

173. Not volumes?—More titles than volumes.

174. Titles?—There are a million and a quarter of books.

175. I want titles?—I think that the number of titles would come to more than the number of volumes, because in the term "titles," we include cross-references; at the Museum, for instance, Peter Pindar's works would be catalogued under Pindar; with-cross references from Dr. Wolcot, and in the first edition of "Waverley," we should put a cross reference from Sir Walter Scott, and so with all anonymous hooks, we should register them as one million and a quarter of volumes. Some works contain 50 volumes, each a distinct publication, but taking one thing with another, including the cross references, and the volumes of works and various other provisos that must be made, I think the number of titles would far exceed the number of volumes.

176. That is one million and a half of titles?—I should think so. I think perhaps it would exceed that. Mr. Jones reckoned three millions of titles, but I think that is too many. They might amount to as many as two millions.

177. **Mr. Foster**—That is not stopping at 1640?—No; of all the printed hooks in the British Museum.

178. **Sir H. Cole**—Have you any notion of the number of languages into which you would divide it? Of course you cannot speak from memory. I suppose that out of this million and a quarter you can approximate to the number of French, German, and Italian, and so on?—I think that perhaps we might—a rough kind of calculation.

179. And how many English?—Yes.

180. Would that be a great deal of trouble to ascertain?—Yes, it would; it would require a good deal of investigation.

181. We are informed that of these titles that you produce, four copies are produced?—Yes, four copies; have you never seen the process?

182. Could you spare one copy?—I do not think we could.

183. Could you without taking it out of the British Museum, in fact—could you allow anybody to have access to one of the sets of the titles and make use of them?—Certainly.

184. If Mr. Arber were asked to go and see these titles he would have full facilities?—Yes, certainly.

185. I mean, it would not be necessary to send somebody into the British Museum to go through the catalogues and pick out all the titles to 1600, and re-copy them?—I am afraid that that would have to be done.

186. **Mr. Arber**—As you quoted my name, allow me to state I would never take from any title whatever, but I always take my title from the actual book.

187. **Sir H. Cole**—That seems a proposition that ought not to have been made to you; but there are a great number of competent persons, I suppose, who if they were asked to look at these slip-titles would get what information they could, and turn it to account.

188. **Mr. Arber**—There may be many people willing to do it, but very few people able to do it. With regard to my transcript, everything was copied by myself.

189. **Sir H. Cole** (to Mr. Bullen)—You have two millions of titles, and you have four copies of each?

190. **Mr. Bullen**—Yes; two millions at the least.

191. And if any competent persons were sent to get at these titles, I suppose you would naturally give them whatever reasonable facilities they might require?—We would give them every reasonable facility.

192. Have you formed any opinion of the cost of making these four copies?—No, I have not.

193. That, of course, could be arrived at by examination?—We have had two very opposite estimates. One would say it could be done for 3d. a title. Now, my impression was that our catalogue was 8d., and that we got somebody competent to get as many titles of our books as possible, and that it would cost the country 3d. That was a very reasonable cost. I think that did not include the cost of printing.

194. That is quite another affair?

195. I suppose in making your proposition to the country to print the English books up to 1640, it was simply a question of expense; if you did not order them to be got down to the present time, it was to get the wedge in?—That is perhaps so.

196. **Mr. Youl**—You confine it merely to the books in the British Museum?—Just so.

197. **Sir H. Cole**—If you wished an angel from heaven to get your entire catalogue printed as quickly as possible should you consider it in a state in which you could print it?—I will answer that with a little circumspection; namely, I would wait until the final incorporation of the old and new catalogues. We are now at the letter S, and the titles under that letter and the letter T are being revised, and the old titles and the supplementary titles are being revised and incorporated, and when those two letters are done the catalogue may be said to be almost finished. There remain U and V, which are one letter with us, and W, which is another, and X, Y, and Z, which are comparatively nothing. I think that in two years I should be in a position to go to press in that rough and ready way that you suggest, and I think that if the catalogue then were printed without any further revision it would be worthy to see the light, and would be. "with all its imperfections on its head," the greatest boon to every one engaged in literary pursuits.

198. That, of course, is not the idea of this universal catalogue. It is a sort of universal affair. But how long do you think it would take to print it?—I have sometimes thought over the matter, and I should think about five years.

199. **Mr. Youl**—You could begin printing at once with the letters that are completed?

200. **Sir H. Cole**—I understand Mr. Bullen to say he would rather finish revising the whole before he went to press?—My reason for that being that in the course of the revision that still remains to be done in the remaining letters, some of the titles would have to be transfered from those letters S, T, U, W to A, B and C. When this was done I would take each volume of the catalogue, strip off the covers, and say to the printer print that. That would be letter-press printing. Straight forward letter-press printing is comparatively cheap. Printing in slips is very dear.

201. The speed of printing would be regulated by the number of competent compositors?—Yes.

202. It would not be greatly reduced in reading the proofs?—No, I think not, but we should have an intelligent staff.

203. I am going to ask you a question which has some bearing on time. Have you ever computed how much composition there is in the *Times* newspaper of 16 pages?—No, I have not.

204. Now, I would venture to suggest to you to put one of your staff that you can trust to compute how much type is used every day in the *Times* newspaper of 16 pages of 6 columns?—I have never made any calculation myself.

205. **Sir H. Cole**—You know that the *Times* does that every day, and I would ask you if you would just look at that when you correct your evidence, and say whether you are of opinion it would take seven years to print it?—I said five.

206. **The Chairman**—Correcting the catalogues?—No; to print it all off.

207. **Sir H. Cole**—I think that if the Chancellor of the Exchequer sent to the trustees, and said that it may be printed the day after to-morrow, or the day after you go to press, I think it would not be two years; but, however, assume it to be two years. I only wanted to test the power of composition when the thing is ready by what is done every day at a great establishment like the *Times*.

208. **Mr. Bond**—The matter to be printed is very different.

209. **Sir H. Cole**—If you recollect, when the earlier art catalogue was first started, a column of the page was printed in the *Times*?—I dare say some of us recollect.

210. Then you would compute how many titles could be got into a column, and how many titles you would fit in the *Times* newspaper. I understand your view to be this—that this would be a rough and ready catalogue which would be of great use as far as it went, so far as telling common-place people what books there are in the British Museum?—It would be better a great deal. It would be the best catalogue that has ever yet been seen. No catalogue in the world, whether in print or in manuscript, is equal to that of the British Museum. It remains only that it should be printed, to make this apparent to every one. I am often myself surprised at the historical information that it has comprised into notes, sometimes of a few lines, and yet replete with knowledge. Some of the first scholars of the day, speaking bibliographically, have been engaged in its compilation.

211. I am going now to ask you something about the universal catalogue; assuming for a moment that it was to be done to enable it to be used by librarians in any form, do you recommend it should be printed on one side of the paper?—I should say both sides.

212. That is a saving of paper; but it is easier to cut it up if you have it on one side?—You can always erase one side.

213. **Sir H. Cole**—For the sake of using in the library, I should ask you do you attach any importance to its being printed on one side?—I think only a certain number of copies need be printed on one side, for the sake of convenience.

214. If that thing ever saw the light it would probably take twelve copies, so as to cut them up?—More than that; we should make numerous catalogues classified catalogues of all kinds.

215. Could you say, just off-hand, how many copies do you think of such a catalogue as this would be useful to the British Museum?—Of your projected catalogue. We should get one copy under the Copyright Act.

216. How many would you advise the trustees to buy for use?—I should say buy a dozen copies; I would do that on my own responsibility.

217. The price would not frighten you?—No.

218. Whatever it was?—We have got four copies of Mr. Arber's transcript, and if your projected catalogue were to be as good as his and not quite so expensive, I should perhaps say more.

219. What is the price?

220. **Mr Arber**.—20 guineas.

221. **Sir H. Cole**—You are on the side of luxury.

222. **Mr. Arber**—Not at all.

223. **Mr. Bullen**—Mr. Arber's reprints are only a shilling a volume, some of them.

224. **Mr. Arber**—I have 100,000 copies at 1s. or 6d. a piece. The reason of the price of the transcript is this; the cost has been wonderful; the demand is so limited; the edition is only on small paper.

225. **Mr. Bullen**—If the price were reasonable, I should certainly be prepared to take a dozen copies.

226. **Sir H. Cole**—If we took a period for doing this it would be your period, 1640 ?—Yes.

227. Supposing we try to get all the English printed books for a period, you would say 1640, of course ?—I do not know that; I think I should advise you, perhaps, to remain at the period you have chosen; yours is a very good period.

228. 1600 ?—Yes, there is this to be said, that it would not include some of our principal early dramatists, not even Shakespeare himself, except in one or two cases.

229. If it is all coming it does not matter, as a matter of convenience, perhaps you would say it would be 1500 ?—1500 would give you nothing.

230. Then you would be disposed to go to 1600 ?—Yes, 1600.

231. **Mr. Arber**—1603. If you make it you get two periods, from the time of Caxton to 1603, and the other from 1603 to 1660, or rather to 1640, and a third period 1640 to 1660.

232. **Sir H. Cole**—I see there is no special point in 1600.

233. **Mr. Arber**—No.

234. **Sir H. Cole**—Do you think it would take a very long time to complete the slips to 1603 ?

235. **Mr. Youl**—To compare them with the titles.

236. **Sir H. Cole**—Oh, dear no.

237. **Mr. Bullen**—The proper way would be to take them through the catalogue.

238. **Sir H. Cole**—I doubt if that would be the proper thing ?—Our slips are alphabetically arranged. It would be much easier to consult the catalogue than the slip.

239. **Sir H. Cole**—I was thinking if one of these four sets which you have, in fact, in use would be the work itself ?—We have all these fours sets in use. I do not think I could spare one of them. I will tell you what has been done with one of the four sets. The title slips are pasted upon thick paper, and attached to them are the cross references belonging to the titles, and those slips are arranged according to the order in which they stand, forming a rough kind of classified catalogue, the other slips are arranged and pasted down in volumes. The fourth copy is a sort of a classified catalogue, not a very good one, but a useful one to us.

240. If you had your own way of printing, what form would you put the rough and ready catalogue into ?—The ordinary form.

241. Would you have it in small pica, or pica, or bourgeois or what ?—This is a very good type. This is bourgeois. The type might be in long primer.

242. **Mr. Tufnell**—Of course you say the old form of figures, not the modern one. They are less liable to error then the modern form ?—In what figures do you mean ?

243. **Mr Foster**—Old faced type ?—Yes.

244. **Sir H. Cole**—You have experience of the Stationery-office printing ?—No, I have not.

245. Do they not employ any printers they like ?—I do not know.

246. Through the Stationery-office ?—We are not under the Stationery-office.

247. Printers of renowned accuracy should be engaged ?—Yes. I should wish the work to be done by accurate printers.

248. You would not make it a matter of competition ?—I am not prepared to say. I think we should have tenders from renowned people.

249. Limited competition ? Should you object to the Stationery-office printing your catalogue ?—No.

250. **Sir H. Cole**—Is there any gentlemen connected with the British Museum who could be found to make an approximation of the English titles from 1603 ?

251. **Mr. Arber**—The museum has about three-fifths of the literature of the time—roughly.

252. **Sir H. Cole**—What is the literature of the time ?

253. **Mr. Arber**—The literature of the time would be any works published during that period. I have given you the estimate up to 1640. In my rough estimate it would be about thirty thousand works. Mr. Bullen has confirmed that by saying that what with cross-references and other things they estimate the catalogue of it at five and twenty thousand titles.

254. **Mr. Bullen**—That was to 1640.

255. **Mr. Arber**—About 25,000 titles. That quite chimes in with my expectation.

256. **Sir H. Cole**—The books printed in English ?

257. **Mr. Bullen**—In English.

258. **Sir H. Cole**—Books printed in England, no matter whether they are Italian or French books ?

259. **Mr. Arber**—Books printed in England, or in English abroad, or by or for Englishmen abroad. The first book printed in America was about 1630. That would go in as a matter of course.

260. **Sir H. Cole**—Is it our business to give books that were printed in America ?

261. **Mr. Bullen**—America was then England.

262. **Mr. Arber**—Of course not, if you deliberately say that is not in your plan.

263. **Mr. Walford**—Books were sent abroad to be printed in order to evade the licensing laws. They could not be printed here because of the state of the laws. You must not shut those books out.

264. **Mr. Bullen**—The first English Bible was printed at Antwerp, and the great Bible was printed at Paris.

265. **Mr. Walford**—English printed books.

266. **Mr. Youl**—It would never do to stop with the books printed in England.

267. **Mr. Bullen**—Many English books were printed at Antwerp.

268. **The Chairman**—Printed in the Colonies and abroad.

269. **Mr. Walford**—English printed books.

270. **The Chairman**—Would you treat America as a colony or as a part of the mother country ?

271. **Mr. Bullen**—A part of the mother country.

272. **Mr. Walford**—They have very excellent catalogues of their books.

273. **Mr. Bullen**—Yes.

274. **Mr. Arber**—May I just say this. The trouble is about the books printed without name, date, or name of printer.

275. **Mr. Bullen**—I think that from merely copying what there is in the Museum catalogue you will get all the information attainable on such points.

276. **Mr. Youl**—If I understand rightly, you would be satisfied with taking the slips in the British Museum ?

277. **Mr. Arber**—I would certainly not trust even the British Museum. I believe that the British Museum catalogue is accurate, and is a marvel as far as it goes, but this is a list of books that I composed on my own responsibility; nobody touched that book but myself.

278. **Mr. Bullen**—You could not possibly do such a work as to get all those titles from the year 1471 to the year 1603.

279. **Mr. Arber**—May I mention one thing. Mr. Henry Stevens, F.S.A., the greatest authority on books relating to America and our colonies there, is now doing a catalogue for Mr. Lenox's library in New York, and he not only will not trust the accuracy of any human being, but he has all the titles of the books copied by photography.

280. **Mr. Youl**—My object in putting these questions is to see whether the work that the British Museum are going to do will relieve us from any expense in making our universal catalogue. If so, then all the titles can be examined.

281. **Mr. Bullen**—If you do that, you know you will never get your catalogue done—I say within a reasonable time.

282. **Sir H. Cole**—Would not the result be that the public would entirely approve of the catalogue being printed up to a given time whatever it may be.

283. **Mr. Walford**—The great objection to that is of course that in certain departments it is incomplete.

284. **Mr. Youl**—It does not profess to be anything except the books that they have got in the British Museum. Then comes the question whether going to that expense it would not be better to make a universal one—a general catalogue.

285. **Mr. Nicholson**—In evidence of the incompleteness of the British Museum catalogue, I may say that the other day I looked in it for three English works by the same author, all published since 1795, and one of which had run through three editions. Every one was missing, and another work by the same man was only entered under a pseudonym, which was treated in the catalogue as a real name; who the author was I found out from an advertisement in a work of his which was in the museum. Here, then, were five deficiencies and one error in regard to the works of a single English writer, and I may add that I have on my own shelves one book, published in 1819, and reviewed in the "Quarterly" by Sir Francis Palgrave, which the museum certainly had not a little while ago.

286. **Mr. Bullen**—Will you let me know the titles of those books—

287. **Mr. Nicholson**—The last is Tabart's "Fairy Tales." I mentioned it to you. The others were by John Lawrence, and I have told Mr. Porter about them.

288. **Mr. Bullen**—They are all in hand (to be supplied if possible), and I will mention before Sir Henry Cole, that scarcely does anybody take up any subject, whether literary or scientific, and come to the Museum and endeavour to ascertain what is our strength in that particular department which he is investigating, but I will show that we want at least one-half of the books he is investigating. This only proves that the Museum, although it can boast of a million and a quarter of volumes does not profess everything; but its deficiencies are being supplied from day to day out of the money voted by Parliament.

289. **Mr. Walford**—I have a considerable proportion of the books that I have had occasion to use; many of my books are on insurance questions; I have in one room 800 books not in Allibone. I propose to fill up the 800 slips, myself, and I know many gentlemen, who, in their own particular branch, will do the same thing, and in that way, with the use of the British Museum cards as a basis, a very complete catalogue might be made. I venture to think, if you spend £20,000 to print the British Museum catalogue now, it would not be the wisest thing to do, and a very little more expense will make it a complete catalogue instead of one which would be very incomplete indeed.

290. **Mr. Youl**—I suppose those remarks apply to the period we are speaking of.

291. **Mr. Walford**—I think there are so many books that have never been into the British Museum at all; at all events until the later period.

292. **Mr. Arber**—I say down to the year 1850.

293. **Mr. Bullen**—You come down too late, Mr. Walford stops at 1840; I acknowledge it at once, because the provisions of the Copyright Act were not put in force then.

294. **Mr. Walford**—I do hope it will be admitted that this catalogue must be English printed books, not simply books printed in England. Under the licensing laws they were not allowed to print books, and they sent them all over to Holland.

295. **Sir H. Cole**—I should say that that was *ultra vires* at present; we may give our opinion about it and recommend it.

296. **Mr. Bullen**—Excuse me, I think you should say at once all books printed in England or English books printed abroad.

297. **Mr. Youl**—I think, henceforward our inquiry will extend to English printed books; after this moment we can decide that it shall extend to English printed books.

298. **Sir H. Cole**—Before 1603.

299. **Mr. Bullen**—Books printed in England, or English books printed abroad.

300. **Mr. Bond**—Would you have all translations of English books?

301. **Mr. Walford**—If you did that you would be opening another field altogether.

[Mr. Bullen's examination concluded.]

Mr. Edward B. Nicholson (Librarian of the London Institution and Secretary of the Library Association) examined:—

302. Supposing the catalogue to be made, should you be in favour of printing it on one side?—I should be in favour of printing only a certain number of copies on one side. I take it that this catalogue is intended to be a section of a really universal catalogue, and, therefore, the size of the entire catalogue must be in contemplation, as well as the size of the English section. Now, the English section alone will fill, in any case, some scores of volumes, if the entries are as full as those before me; how many will it fill if you double the number of volumes by printing only on one side of the page? To hold the entire catalogue you would require a separate room. I say nothing of the expense of paper and binding for double the number of volumes.

303. The object of printing on one side will be to enable each library to cut it up as it thinks fit?—Libraries will not be able to afford to buy one merely to cut it up in that manner.

304. You have heard the British Museum can?—They do not do it in this way, they take four copies by a simultaneous process.

305. It is not a very big question, printing on the one side or the other, but as the universal catalogue is specially for the use of libraries, people who have special libraries and want catalogues of books are so small in number that, although it is quite worth while attending to their wants, it would seem right to bear in mind the wants of the public libraries. Well, then, of course, you may print it on both sides, and they can strike out one side if they want to classify it at all; and the question I should ask you is, whether you did think it would be better to print on one side only for those libraries who would like to cut it up and arrange it in their own way, or whether you would on both sides?—I would print on both sides for the general run of purchasers, but I would print on one side for a certain number who might prefer it.

306. Do you concur in what has been generally expressed, that the first part of the catalogue should go down to 1603?—I think it is one of the worst dates that could be chosen. In the first place, it cuts into the middle of a great period of English literature, in the second place, it cuts into the middle of the life and writings of England's greatest author. I do not approve of 1640, that divides the literature of the struggle between the Parliament and the King. I prefer 1660 to that.

307. Do you approve of 1600?—Rather worse than 1603, that is, three years worse.

308. Will you say what period you could recommend as being least open to objection?—I would recommend the very last day before going to press.

309. Now you are going beyond the period. We are asked to say whether it should go to 1550 or to 1600, and now we are suggesting in order to get a piece of the work done within a reasonable time, eighteen months, to have those times from the invention of printing to 1600. What advice have you to give, do not bring us up to to-day, because I do not consider that is a comparison?—Well, if you must do it, I would rather cut it short about 1550, and begin a new period then, but I certainly do not commit myself to that precise year.

310. Are you in favour of printing it in periods of whatever may be decided—say 50 years, or otherwise—or are you in favour of waiting 150 years before you begin?—I think that the whole thing might be done, on a very much larger and more complete scale, in a different manner from what you suggest, and I should like to have the opportunity of explaining my views. My views are that what you want is a subject catalogue. You want your books arranged according to subject; you do not want them arranged according to years. That may suit one sort of bibliographer, the man who takes an interest in books simply as typographical antiquities, and to whom it makes the greatest difference whether, after the date on a title-page, there is or is not a full stop; and it would suit the historian of any particular branch of thought. But to 999 men out of 1,000 a subject-catalogue would be of infinitely greater value—a catalogue that would enable them to see all the books that had been printed in English upon architecture. I would ask librarians to agree upon some scheme of classification. The British Museum classification may be a very good one for its own purposes, but it is entirely unscientific, and could not possibly be adopted for a printed catalogue. Mr. Melvil Dewey's is infinitely better, and might be made the basis of the scheme to be adopted.

311. If you take architecture you want chronology as well as subject classification. You may say that you take the author's names and put them alphabetically, and you may say that you would take the books in the order in which the world has produced them. You have not explained what you have to do with architecture, until you have shown what you have to go on, have you any advice upon that?—It would almost be better, for the purpose of explaining my principle of the kind of classification, to take physics instead of architecture, because I can tell you in a moment how to sub-divide physics. I say first of all take the general works on physics.

312. You take physics, and you may divide it just as you like, but when you have taken sub-heads, whatever they are, supposing that you take the department of physics as a sub-head, then how would you arrange it under the sub-head?—Then you may arrange either by author's name, and where a book has no author's name by the catch-word or the subject-word of the title, or else you may arrange chronologically; I am not prepared to say at once which is the better. If you arranged chronologically, you must have an author and title index.

313. In starting with the alphabetical as the head and, beginning with the chronological, and taking the alphabetical, you have that principle to determine?—If you are not going to arrange subjects, I should say adopt the alphabetical order, and add, if possible, a chronological as well as a subject; but your catalogue would be ten times more useful—an hundred times more useful—if you had it arranged according to subject.

314. **Mr. Bullen**—Are we not travelling quite out of the course; we are not discussing the question of a classified catalogue.

315. **Sir H. Cole**—You were not present when the business began, when it was attempted to be shown that the work to be produced in the first instance was really for the use of libraries, and not for the general public; it was a stocktaking of the books that had been brought into existence?—That is just the point which I was considering. To a man whose library has any appreciable number of works in it, a subject-catalogue is of paramount necessity.

316. The first business of a librarian, in my mind, is to get his library complete; then the use to be made of it, the first thing is to collect books, and to make them accessible, is not it, to know what he wants to know, and what he has got and what he ought to have?—Without a subject-catalogue he cannot know what he has got, and what he has not got upon a given subject.

317. **Sir H. Cole**—I think this is a fair discussion.

318. **Mr. Bullen**—It is merely a matter of arrangement of the catalogue. I suppose the Society intends to print this catalogue in alphabetical order, according to the authors' names; there may be certain rules for anonymous works.

319. **Sir H. Cole**—There is a specimen here?—It is contemplated that you should take it chronologically for certain periods—1500, or whatever it may be.

320. **Sir H. Cole to Mr. Nicholson**—You begin at this point, if the universal catalogue is to be produced you say that it should be divided into subjects?—I do. I should also like to point out the bearing of such a division on the question of expense. I believe that such a catalogue would not only pay its own cost, but would be one of the most profitable works that has ever been produced. Societies and individuals would not buy an unclassified universal catalogue, but they would buy the particular volumes which interest them of a classified universal calalogue.

321. **Sir H. Cole**—Allow me just now to interpose, and to ask Mr. Bullen, whether he concurs from the commercial point of view?

322. **Mr. Bullen**—I do myself, possibly to a great extent. I think it would be most desirable that there should be catalogues of special subjects.

323. **Mr. Nicholson**—I should like to make one suggestion which I think will be found to be entirely my own, and that is, that every book in the English section, and in the universal catalogue as a whole—if it is ever done—that every book should have printed against it in the margin a nominating number, being a distinct number from that of the preceding book. For instance, suppose that Caxton's "Game of the Chess," and the "Fifteen O's," and the "Golden Legend" chanced to follow each other (which, of course, they would not). Then, if the "Game of the Chess" had printed against it in the margin 15, the "Fifteen O's" would be 16, and the "Golden Legend" would be 17; and, after that had been done throughout, any great library, instead of having to print a catalogue of its books, would need simply to print a list of the numbers attached to those books in the universal catalogue. For instance, the British Museum would have merely to print a list of the numbers 15, 16, and 17, which would show all the works that the British Museum had. The Bodleian would print its list, from which it might appear that they had only number 16, and Cambridge University would print its list in which only 16 and 17 might appear. It would only take a few weeks to print such a list for the largest library

in the world; and the reader would, by comparing its list of numbers with the universal catalogue, be able to see at a glance whether Caxton's "Game of the Chess" was in that library or not.

324. Sir H. Cole—In the same way as every ship at Lloyds' has its number.

325. **Mr. Arber**—There was a book called, "The Institution of a Christian Man," published in the reign of Henry the Eighth. There were five editions of that book all printed in the same year, with the same title-page?—Supposing there were five editions of Caxton's "Game of the Chess," you would number them 15^1, 15^2, 15^3, 15^4, 15^5.

326. **Mr. Arber**—How are you to be able to determine which of those five editions you have in your hand and are going to use?—I would give a separate entry to each edition, certainly.

327. **Mr. Bullen**—Where a book is printed 15 or 16 times in the same year?—Yes.

328. Sir H. Cole—I think we have selected which period?—I know nothing further than that 1600, 1603, and 1640 are all objectionable epochs, and something near to 1660 or 1550 might be best.

329. About the notes. (To Mr. Nicholson.) Do you agree with Sir James Lacaita that all notes should be in Latin?—Regarding this as a section of a possible universal catalogue, I should say decidedly so; because, suppose I have a book in my library in Hungarian, and want to consult the Universal Catalogue about it. I cannot be expected to know Hungarian, nor could a Hungarian librarian be expected to know English; but both of us would know Latin.

330. **Mr. Bullen**—I am afraid that the knowledge of Latin is not so very general as Mr. Nicholson thinks it is.

331. Sir H. Cole—Then do you say it should be in Latin?—It would do very well as a means of intercommunication between Hungarian and English if they did not know, but you see we have fallen out of the use of Latin. I should not like to write a long letter myself in Latin.

332. What language would you suggest which would be that in which the majority of the librarians should be able to write notes. Do you qualify your answer by saying English?—Certainly English if not Latin, since English is spoken by far more people than any other European language, and is certain to become an universal language.

333. **Sir H. Cole** (to Mr. Nicholson)—The question is whether each nation should write its notes in Latin, supposed to be universal, or whether it should write it in the language of its own country, and your answer is Latin?—My answer is, that to librarians and readers of all nations, Latin is a better understood language than the language of any one of them.

334. I suppose you are not disposed to qualify your answer by saying, in English if not in Latin?—In English, I would say decidedly, as the language already spoken by the most people, and likely one day to be really universal.

335. **Mr. Walford**—You must remember, that these sections will be resorted to by the best librarians; therefore, I would rather he did not even qualify his answer.

336. **Mr. Youl**—I think there are as many Hungarians who understand English as there are Hungarians who understood Latin; this is to be a popular thing.

337. **Sir H. Cole**—Have you any opinion of what the cost is likely to be?—I have no means of estimating, and I should not like to give a guess.

338. Have you any means by which you can estimate the number of books printed before the period of 1660?—I have not.

339. Would you go to a printer of renowned accuracy?—I think you generally have to pay heavily for renown, but in any case, you must have thoroughly accurate proof-readers. The accuracy of the slips would be ascertained beforehand.

340. Sir H Cole—Allow me to interrupt you; would you not take the catalogue of the British Museum as sufficient?—That is one of the points that I should like to say a word or two about presently. I will not be long, but I want to finish this question. The slips should be carefully verified before setting them up, and the proof-readers should compare every word of print, letter by letter, with the original slip; there would be no room for error with thoroughly trained and careful proof-readers. As to printers, the only three firms with whom I have had to deal, might each be trusted to print anything very fairly indeed; and, in fact, it would be to their interest to do so, because the printing of this catalogue would give them a certain reputation, and they would obtain a large amount of work of a similar description. Therefore I would at least allow a fairly wide competition. With regard to the 10th question, of course I would suggest that; but I would suggest, also, that every society, and every library, sent to the central clearing-house a copy of each of its catalogues and indexes. With regard to the 11th question, I should certainly hope that the University libraries would give their co-operation. And there is one point I should like to press on the Council; that is, that it should try to get the co-operation of all the libraries in England and America. It must be remembered that there is not only an American Library Association, of which all the heads of the library profession in the United States are members, but there is also a Library Association of the United Kingdom; and when I say that Mr. Winter Jones is the president, and that the librarians of the Bodleian, Advocates' Library, and Trinity College, Dublin, are the vice-presidents, and that the rest of the council are other leading librarians, and that the Association holds monthly meetings in London, and annual meetings in different parts of the kingdom—it is surely of the greatest importance that their co-operation should be invited.

341. Do you think you see your way to do it?—We have got the will, and it is easy enough to find the way.

342. **Sir H. Cole**—I find things are very difficult to do. I do not know if there is here one of you who will see it done. You are aware from the statement of old Mr. Dilke, of the *Athenæum*, who pointed out how important it would be to have the universal catalogue. I brought the subject before the Society of Arts, after the Exhibition of 1851, and then it went to sleep, and then it turned up again in 1874. I may say it has turned up again. Then there has been since that time a consideration on the subject. I should say that the Prince might be very fairly advised, if the conference of librarians would put forward a scheme that would give a reasonable guarantee for the beginning of the thing, that nothing could be better than that the very learned people connected with libraries should have it in their hands. But now, this very morning, we have had some new shots put into our locker altogether, and every one has a different opinion on every point. I think the first thing that we shall get if we go to work rightly will be a printed catalogue of the British Museum as the beginning. We might see our way to getting a return before Parliament of all books in the British Museum, up to the year 1877.

343. **Mr. Nicholson**—That would be no help towards the universal catalogue, except in so far as you might cut up the book and copy the titles by the fourfold process.

344. **Sir H. Cole**—We have not arrived at any agreement in the mode of proceeding; we have not arrived at

how much to pay; we have not arrived at any settled stages at all. But if Mr. Bullen could put into our hands that which we can get, there would be nothing to do but to buy two copies and cut it up, and some basis would be laid.

345. **Mr. Nicholson**—I was going to offer further suggestions with regard to co-operation. In cataloguing books printed in America, you would get the hearty co-operation of the Educational Department at Washington. You must remember that at very great expense and labour they have produced the most important work on library-science ever published, and they would have full sympathy with such a project as this. As regards European Governments, the French Government should be first communicated with, because it sent over a special delegation to the Conference of Librarians, and there can be very little doubt of its willingness to co-operate.

346. **Sir H. Cole**—I quite agree with you; I believe that there is more sympathy out of England than in England, and I believe that by degrees we may become the responsible persons to take interest in it, but my conviction is certainly that the printed catalogue of the British Museum library would commend itself to a great many libraries and people throughout the country?

347. **Mr. Arber**—Yes; it would be a valuable boon that the British Museum catalogue should be issued as a Parliamentary paper.

348. **Mr. Nicholson**—I should be perfectly content to take the British Museum slips as the basis for the English section of an universal catalogue, without going to the title-page of every book, because I cannot conceive within what time you would otherwise get your English section finished.

349. **Mr. Bullen**—There is one topic in reference to the catalogue of English printed books in connection with Mr. Arber's Transcript of the "Stationers' Company's Registers," which remains to be mentioned. There are in this book of Mr. Arber's, numerous entries of which there are no books extant as far as we are aware. Should those non-extant books, as far as we are aware, be included in the proposed catalogue of books down to the year 1603, or should it be that we take the lawyers' maxim, *de non apparentibus et non existentibus eadem est ratio?*

350. **Sir H. Cole**—I should say your business is to get any title out when you have any evidence at all that the book did exist, not to admit it upon a judgment of which you have no evidence. I should say that is a very good basis.

351. **Mr. Arber**—Everything you have not got a copy of extant, you reprint from "Transcript." One-third of the literature is, however, not in the catalogue, and I tell you why; because books published under patent never came to the Stationers'-hall for registration.

352. **Sir H. Cole**—Therefore you would not take that as exhaustive. **Mr. Bullen**—A great help. **Mr. Arber**—That is why I did it.

353. **Mr. Bond**—Do not you think that rule 4 requires consideration as to the periods? Take English alone; how many divisions of period would you allow for the English literature?

354. **Mr. Arber**—All nations did not produce books in equal quantities.

355. **Mr. Bond**—Take English alone; how many chronological sections would you allow?

356. **Mr. Arber**—As far as English literature is concerned, I go no further than 1660; beyond that I am not fully confident in my own knowledge.

357. **Mr. Nicholson**—May I point out one great fault in the chronological catalogue? You ought to be able to find all your editions of Gower or Chaucer together, but, according to your chronological arrangement they will be scattered through all the periods.

358. **Mr. Bond**—How would you act with regard to Shakespeare?

359. **Mr. Youl**—The only reason why we adopt this special date is that we must have a beginning.

360. **Mr. Bond**—Whatever you do must be complete.

361. **Mr. Nicholson**—The kind of catalogue you have had in mind would be condemned by every librarian throughout the world.

362. **Mr. Arber**—May I now suggest to you the plan upon which I intend to do the final and fifth volume of the Transcript. I will show, I think, I have met every difficulty that has been raised to-day. I purpose giving to the titles of the books a classified catalogue under each year of all the books which were printed in that year, beginning 1471, whatever the first date was, and so on. I purpose printing it on writing-paper of the size of this book, in two columns, with spaces on either side, for writing on; that gives you the survey of the literature of the year under the various classifications of subjects for the purpose of study in any particular branch. You can print at the end an index of authors, then an index of subjects, then an index of printers, then an index of editions, then an index of the persons to whom the books are dedicated—all those indexes serve for special researches. For the purpose of persons who study literature, they want a survey of all the books in in one year in a few pages. That, of course, would not be complete in a sense. Then spaces should be left for the additions by the librarians of works that they have in their own libraries, and that is the only solution that I can see in my own mind. And in the 4,000 pages you can produce every title in the period from the time of Caxton to the time of 1660, and they will all come within a space of time, and all that the libraries will have to do will be, they will have to buy a copy of this book, and can put against the margin the press mark of such a copy as they have got. A librarian could know in a moment when he took up this volume in respect to such books in English literature that Mr. Arber had obtained, what have I got, and what have I not got.

363. **Sir H. Cole**—I should like just to point out some facts which bear upon your question of fixing some period, when you argue in favour of the universal catalogue. I point out to you that, having once produced a catalogue in the British Museum up to a certain period, we have all been working for the last quarter of a century, and here we are, without any advance upon this question of a printed catalogue. Now, I ask any gentleman present how any kind of voluntary association without the national purse, with nothing but the good-will which may exist for a few years, and then begins to die away, can hope to accomplish such a work.

364. **Mr. Bullen**—It seems to me the Government would never give their aid to a problematical scheme.

365. **Sir H. Cole**—I think that if public libraries assisted, if the Society of Arts, and other bodies who may be interested co-operated, and with the good-will of the public authorities, which it is assumed there would be, if it were seen to be a sensible thing; and with the aid of Members of Parliament, and bringing all those forces to bear, you would get a catalogue of the British Museum printed. I think it could be done in a short time. The question is, whether you would not attempt rather to combine all those forces, and get it done, rather than suggesting various other ways of doing it, and doing nothing.

366. **Mr. Bullen**—It depends upon co-operation.

367. **Sir H. Cole**—I am very strongly impressed, after the discussion of to-day, that the Society might help in its own way by getting subscribers for the work

everywhere, say for £3,000 or £4,000. I think that with the knowledge we have of the good-will of the British Museum trustees, of the practicability of the scheme, and, obviously, of the public want and desire, the case might be put to the Chancellor of the Exchequer; and if we can get all that done, I think we should save Mr. Bullen the very great labour of eleven years.

368. **Mr. Walford**—There is a good deal in that.

369. **Mr. Nicholson**—Then your British Mnseum catalogue must either be made a subject-catalogue, or have a subject-index.

370. **Mr. Bullen**—The first thing should be an alphabetical catalogue. The index afterwards would be a very great boon, and, indeed, a necessary complement.

The Committee adjourned.

(*To be continued.*)

MISCELLANEOUS.

USE OF STEEL FOR STRUCTURAL PURPOSES.

The following is the final report of the Committee of the British Association on the use of steel for structural purposes :—

Owing to the action of your Committee, the Board of Trade requested two of your members, viz., Sir John Hawkshaw, F.R.S., and Mr. W. H. Barlow, F.R.S., to co-operate with Colonel Yolland, "To consider whether it is practicable to assign a safe co-efficient for steel."

After a long and careful consideration they, on the 19th March, 1877, reported as follows :—

We assume that with steel as with iron, the engineer will take care that as well as the required strength, he secures a proper amount of ductility.

Having given the subject our best consideration, we recommend that the employment of steel in engineering structures should be authorised by the Board of Trade under the following conditions, namely:

1st. That the steel employed should be cast steel or steel made by some process of fusion, subsequently rolled or hammered, and that it should be of a quality possessing considerable toughness and ductility, and that a certificate to the effect that the steel is of this description and quality, should be forwarded to the Board of Trade by the engineer responsible for the structure.

2nd. That the greatest load which can be brought upon the bridge or structure, added to the weight of the superstructure, should not produce a greater strain in any part than 6½ tons per square inch.

In conclusion, we have to remark that in recommending a co-efficient of 6½ tons per square inch for the employment of steel in railway structures generally, we are aware that cases may and probably will arise when it will be proposed to use steel of special make and still greater tenacity, and when a higher co-efficient might be permissible, but we think those cases must be left for consideration when they arise, and that a higher co-efficient may be then allowed in those instances where the reasons given appear to the Board of Trade to justify it.

We are, &c.,
(Signed) John Hawkshaw,
W. Yolland,
W. H. Barlow.

The Secretary of the Board of Trade, &c.

This report has since been acted upon by the Board of Trade in the printed paper issued by them in reference to railway structures.

It will be observed that a co-efficient of 6½ tons per square inch is assigned to steel, that of iron being 6 tons per square inch.

This increase of the co-efficient will effect important economy in structures, especially in bridges of large spans, and will also tend generally to increase the employment of steel for railway and shipbuilding purposes.

The labours of your Committee having ended in such a satisfactory manner there is no necessity to re-appoint them.

We remain, gentlemen,
On behalf of the Committee,
Yours faithfully.
E. N. Carbutt, *Secretary.*

CORRESPONDENCE.

PORT OF AYAS.

As Capt. Cameron is now advocating the port of Ayas, I beg to confirm the value of this port by referring to my paper read before the Society on the 22nd Nov., 1871 (vol. xx, p. 21), Lord Henry Lennox, M.P., in the chair, "On the Progress of the Through Railway Route to India." I then said:—

"To the south of Konieh is to be found one of the great difficulties of the undertaking, the passage of the chain of Taurus, by the famous pass, now called the Gulek Boghazi, by which Cyrus and Alexander entered Cilicia. Upon this it is not needful to dwell, for there is no reason to consider this pass impracticable, though undoubtedly difficult and expensive. On emerging from the pass, the Mediterranean is in sight, and ports are available for the export of the produce of the interior. It has long been the desire of the Government to carry any through line around the Gulf of Skanderoon, so as to cement all the neighbouring ports.

"We have come now to the point where an intermediate port is to be found for working, temporarily or permanently, the railway from the Mediterranean to Bagdad, in connection with steamers from Brindisi. It will, however, be seen that another way will be opened from Salonika. Mr. W. P. Andrew long favoured Suedieh, and the restoration of the port of Seleucia, but is now, it is understood, ready to accept Skanderoon. The Government have wished not to displace the old port of Skanderoon for the creation of a new town. I accordingly obtained a survey of Skanderoon and the Beilan pass by Colonel Messoud Bey about the year 1865. The Colonel pronounced on its practicability, and this is confirmed by Mr. Telford Macneill and Mr. W. J. Maxwell, who, in 1870, spent a considerable time in the careful study of the district. It is, however, within possibility that the cost of getting over the pass may be much reduced. Colonel O'Reilly has made a suggestion which is of considerable value, that the port shall be at Ayas, on the north shore of the Gulf of Skanderoon. This would better accommodate the local traffic from the interior of Asia Minor, and it would be more accessible for Indian steamers than Skanderoon."

Colonel O'Reilly wrote to me :—

"From Konieh to the Taurus is a rich country, with isolated hills, which can be avoided by slight deviations. The highest points of the Gulek Boghazi can be reached with very little tunnelling, and the ascent and descent made with far lighter gradients than those of the Sœmmering or the Ghauts line. The town of Adaua would be on the line, which should reach the sea at the great natural harbour of Ayas, one of the best protected in the world, the opening looking across the bay towards Alex-

andretta, to which it is far superior as a port. Thence the line would go round the Gulf, or rather Bay, and over or under the Beylan pass, and on by the Andrew line.

"It is curious that in all the discussions on the through line to India, no allusion has ever been made to this port; yet it is undoubtedly here that the Euphrates valley line should have its terminus, even if considered as a finality, and not as a section of a future through line; for, supposing the sea to be used for communication with Europe from the Gulf of Issus, this port is farther on in that direction, and its climate is perfectly healthy, there being no marshes in the neighbourhood, nor hills to obstruct the breeze from whatever quarter it blows.

"The port of Ayas would become the outlet for a great part of Anatolia, and by the Andrew line for Northern Syria, Koordistan, and the Tigris Valley, it would undoubtedly soon rise to be a place of great commercial importance, and the rich plains immediately inside it would no longer remain as they are, uncultivated, the home of a few nomad Turkomans. I am sure that the Government could, by the sale of town allotments along its quays, and farm lands in its interior, find money sufficient to construct a branch line to Kaiseriëh from above the Gulek Boghazi, or from the port to Marash. This is how things are done in America, and how she makes her railways and pays off her debt. In the mountains which surround Cilicia there is a population now living in semi-idleness which would be at once ready to descend and cultivate the plains, if the market for produce was brought near. I am sure that the Armenian community alone would find the money for either of the branch lines I mention, in consideration of grants of lands in the neighbourhood of Ayas."

Hyde Clarke.

RECENT OBSTRUCTIONS IN TELEGRAPHY.

The interesting paper read by Mr. Preece at the meeting of the British Association, at Dublin, is very liable to promote misconception as to the influence of the Telegraph Department upon telegraphic invention. At the commencement of his paper, Mr. Preece says that "it has been publicly stated by very high authorities that, since the transfer of the telegraphs to the State, invention in that art has left the shores of the United Kingdom and flown to those of America. Moreover, it has been intimated that the monopoly in telegraphy possessed by the State has checked improvement. Such statements are made in ignorance of the facts. Invention has not left the shores of England. The English Telegraph Department stands in the first rank. No one has ever been heard to complain of the action of the Post-office in adopting improvements, but, perhaps, some disappointed inventor." Probably Mr. Preece is right in the assertion that no one complains of the action of the Telegraph Department of the Post-office except disappointed inventors. This, indeed, as I understand the question, is all that the authorities, and others to whom Mr. Preece refers, have felt it needful to insist upon. Of course it is absurd to claim, as Mr. Preece does when speaking of telegraphic invention, that "the English Telegraph Department stands in the first rank." He mentions the most prominent telegraph inventors, and the principal telegraph inventions, but he does not, and cannot claim anyone of the former as connected with the Department, or of the latter as emanating from it. In fact, the claims put forth by Mr. Preece were completely negatived in the course of the discussion which followed the reading of his paper. Mr. Bell, the inventor of the telephone, said, "he wished to call attention to one or two points. Mr. Preece had said that the Government control had not tended to hinder invention in this country. His personal experience of Government control had been this. In the beginning of the year 1874 he invented in America a system of multiple telegraphy, by which 16 or 20 messages might be sent simultaneously on a single wire, and this was submitted by him to the Telegraph Department of the British Government. In reply to his request for an investigation he received a printed paper, such as probably was sent out to every inventor who applied to the Postal Department. It stated that the Post-office Department would take into consideration the invention submitted at the expense of the inventor, and that in the event of the improvement in telegraphy being thought worthy to be adopted by the Government, the question of remuneration would be left entirely to the Postmaster-General. It was that reply which induced him to bring forward his invention in America. He brought his system of multiple telegraphy before the telegraph world in America, and the outcome had been the telephone. He should be the last man to say that Government control was not necessary in this country for the sending of telegraphic messages for public use. Still, he believed Government control to be destructive of invention."

My own experience of the Postal Telegraph Department coincides with that of Mr. Bell. Indeed, my experience having been gained during a negotiation with the Department which has lasted for more than seven years, entirely supports the views which have been expressed in opposition to Mr. Preece's statements. A short time since I was advised that, as I had a strong case against a public department, it was my duty and my privilege to lay it before the Queen, with the consent of the Secretary of State, in the form of a memorial, and on the 28th of June, 1877, I received the following acknowledgment from Whitehall:—

"Sir,—I am directed by Mr. Secretary Cross to inform you that he has laid before the Queen the petition which accompanied your letter of the 19th instant, and that it has been referred by her Majesty's command to the Postmaster-General, to whom all further communications on the subject to which it relates should be addressed.

"I am, Sir,
"Your obedient servant,
"A. F. O. Liddell.

"Mr. Richard Herring."

On the 25th of December last, I wrote to the Postmaster-General, reminding him that my petition, which the Secretary of State informed me six months previously her Majesty had graciously referred to his Lordship, had not received any attention. The receipt of this letter was simply acknowledged on behalf of Lord John Manners, by Mr. Parkhurst, the chief clerk of the Post-office, to whom I wrote the same day, as follows:—"Surely it cannot be right when a subject has exercised his constitutional privilege of petitioning the Queen, with the approval of the Secretary of State, and when the Sovereign has been graciously pleased to remit such petition for the careful consideration of one of her Ministers, for the Sovereign's commands to be treated with contempt? Kindly consider this matter, and let me have your views."

No reply, however, to either communication has been sent to me by the authorities of the Post-office. The substance of my petition was as follows:—

Shortly after the acquisition of the telegraphs by the Government, I was informed that the various efforts which had been made to print the telegraph alphabet by definite signs had utterly failed, and that in consequence of the frequent errors arising from what is known as the Morse system, the authorities of the Post-office had determined, if possible, to obtain some other and more definite method.

In consequence of this information I brought my system under the notice of the authorities of the Post-office, but the Engineer-in-Chief of the Telegraph De-

partment condemned the invention because the telegraph signs by my system were printed; and he informed me that it was a *sine qua non* that the signs should be embossed. To emboss telegraph signs vertically on a narrow strip of paper at the same time that the paper receiving the signs was being unwound and carried forward by clockwork, occasioned no little difficulty. To make and break a longitudinal mark drawn on the paper slip by the Morse system was a very easy matter indeed compared with the suggestion to emboss definite telegraph signs vertically while the paper was running, and with as much distinctness as would be required to form a book for the blind. This difficulty, however, I succeeded in overcoming, and on the 30th January, 1871, an inspector was sent from the General Post-office to examine and report upon my instrument. On seeing it he at once condemned it because it was an embosser and did not print. I then wrote to the Secretary of the Post-office, stating that my first model had been objected to because it did not emboss; and that the second model had been condemned because it did emboss, and I asked him to be good enough to inform me whether the Department preferred printed or embossed telegraph signs. The Secretary replied :—"February 6th, 1871 :—There is no intention on the part of the Department to revert to embossing processes."

An official copy of minutes and correspondence, which is in print, has the following remark addressed by the Engineer-in-Chief to the Secretary of the Post-office, prior to the date of the letter which I have just quoted. "Of course, even though there is no doubt Mr. Herring's invention is useless, I will have it seen." And shortly afterwards, 18th April, 1871, the Engineer suggests to the Secretary in a fresh minute, "we might allow Mr. Herring to try his instrument on a line where it would no doubt die a natural death." Of course I was not content that my instrument should be tried on any such line; and, on the 18th of the following month, the Secretary of the General Post-office wrote to me, "that my system was much superior to the numerous methods which had been brought forward from time to time during the last twenty years." And shortly afterwards he wrote to me, and proposed that my instrument should be fairly tried by Sir William Thomson and Professor Jenkin, thus ignoring the opinion of the Engineer-in-Chief altogether, who in one of his official minutes had actually reported that it was "impossible to produce readable signs" by my instrument, and that the instrument was "practically worthless."

The proposal, however, for a full and fair trial of the invention which the Secretary of the Post-office suggested, was couched in terms to which considerable objection might have been taken by me. For instance, the Secretary proposed that while the trial was pending the Department, "even (said he) if it forms an adverse opinion with regard to your instrument, will abstain from expressing that opinion," and therefore, he added, "the Department would expect me to abstain from publishing *ex parte* statements." Thus he proposed a trial of my instrument by scientific persons as a guide to the judgment of the Department, and yet he admitted that the Department was capable of allowing itself to form an adverse opinion with regard to that instrument while the trial was pending. The arrangement of the terms of reference was next proceeded with. The terms of reference required as follows:—"It will be desirable that you (Sir William Thomson and Professor Jenkin) should test the wire which is to be used before Mr. Herring's instruments are put on it, and that you should satisfy yourselves that the insulation of the wire is effective." And further, "the instrument is not to be condemned or reported against for any mere flaw or accidental hitch in the working as distinguished from faults, if any, in the system, and any fault of detail is to be reported to Mr. Herring, to give him an opportunity of overcoming it before you finally report on the merits of the instrument."

The proposed trial of the instrument was commenced by Messrs. Thomson and Jenkin at the Central Telegraph-office, in the month of October, 1872, but as I observed a manifest want of attention on their part to the terms of the reference, I called on the Secretary at the Post-office, and detailed the grounds of my objection to any report being written unless the terms of the reference were heeded, and the trial of the instrument conducted accordingly. I afterwards called on my solicitor, and handed to him a memorandum of what had passed between me and the Secretary. This memorandum was forwarded to the Post-office by my solicitor, and the Secretary wrote acknowledging it to be "accurate as far as it goes." After all this had taken place, however, a report was actually made and signed by Messrs. Thomson and Jenkin without proper trial, although the Secretary of the Post-office had admitted that further trial was necessary.

In accordance with the terms of the reference, which required that the instrument should not be reported against for any accidental hitch in the working, but that such should be first reported to me, in order that I might have an opportunity of overcoming it before a final report was made, the referees informed me preliminarily, in writing, that some of the symbols received by my instrument were imperfect; but, they added, that they thought it might have arisen from the "rapid and somewhat jerky style of keying practised by the telegraph clerks." This, in fact, was the case. The referees added, in the preliminary report from which I am now quoting, "It is very desirable that an automatic sender should be arranged to send slips with actual messages, so that they may be recorded by Mr. Herring's instrument, as no trials can be quite satisfactory which do not exclude the imperfections of sending." With reference to this suggestion, a special minute, penned by the Secretary of the Post-office, and dated November 18th, 1872, may be seen amongst the papers officially printed. It is as follows:—

"Write to Mr. Fleeming Jenkin with reference to his preliminary report on Mr. Herring's telegraph instrument, and request to be informed whether he is still of opinion that the Department should make, at its own cost, an automatic sender for the purpose of further testing Mr. Herring's instrument." To which Mr. Fleeming Jenkin replied :—"In answer to your letter of the 18th instant, I beg leave to say, that I think it unnecessary that an automatic sender should be made by the Department, unless the officers of the Department think it desirable." Of course this letter of Professor Jenkin is utterly inconsistent with the rules which govern the conduct of referees, and with the ordinary principles of justice. It comes, in fact, to this, that one of the referees writes to one of the parties to the reference to inquire whether that party thinks it "desirable" that a step should be taken which the referee had previously declared "very desirable" for a satisfactory trial. In effect, the referee applies to one of the parties for directions as to the method of proceeding in the reference. A reference thus conducted would be an absurdity, and its results must be nugatory, and accordingly, the Secretary admitted that something more would be necessary to a satisfactory trial, and within a month of his correspondence with Professor Jenkin, he gave his consent in writing for a further trial. It is unnecessary for me to analyse the report which Sir William Thomson and Professor Jenkin undoubtedly signed, and for which they were paid enormously by the Post-office, although the Secretary knew at the time that such report was based upon no proper trial, and that he had even given his consent in writing for a fresh trial on the terms of the reference. When, however, the report appeared, I dealt with it and forwarded my remarks to the Secretary of the Post-office. Indeed, Messrs. Longmans published the report with my remarks in parallel columns.

The claims which I make for greater speed, greater accuracy, and greater economy, are all sustained by that report when it is read by the light of the comments which I have appended to it, and it is interesting to contrast that report with the opinions of the scientific advisers of the Post-office at the outset of the discussion, when they denounced my instrument as "practically worthless," and stated that it was "impossible to produce readable signs" by it. No less an authority upon telegraphic science than Mr. Latimer Clark, has stated, upon evidence which cannot be questioned, that my transmitting slip for the alphabet has only 82 perforations, and measures only $10\frac{1}{2}$ inches, against 164 and 14 respectively on the Post-office system. That my alphabet receiving-slip measures less than 5 inches, against 15 inches by the system in use at the Post-office. That, instead of the signals failing, as Professor Jenkin stated, Mr. Latimer Clark finds my instrument capable of recording 1,600 perfect signals in a minute, and that this has been actually accomplished by an instrument which has been subjected to harsh experiments for several years, and was not made by a first-rate maker. Mr. Latimer Clark also affirms that my system would not only surpass the system in use at the Post-office, both in speed and accuracy, but that it would save nearly 75 per cent. in the cost of paper.

The fact of the instrument which I submitted for trial not having been made by a first-rate maker, introduces another division of my costly experience of the Telegragh Department. Owing to the influence of the engineers of the Telegraph Department of the Post-office upon the instrument-maker I first employed, I was compelled to seek for other assistance, and applied to several makers without success, and as this difficulty seemed to become increasingly serious, I mentioned the fact to the Secretary of the Post-office. In replying to my letter, he said, "You do not appear to be conscious that you are imputing dishonourable conduct to honourable and upright public servants," and after contradicting me five times, saying twice, "It is not true," he informed me that he had written to three of the instrument-makers whose names I had mentioned, and had requested each of them to explain; and yet, without waiting for their replies, he added, "I must request you at once to withdraw the imputation, which should never have been made." As it was impossible for me to withdraw a single word that I had communicated to him, I simply acknowledged the receipt of his letter, and awaited the result of the inquiries which he informed me he had made. In a few days I received a letter stating the result of those inquiries, and requesting me once more to withdraw the imputations, to which letter I replied as follows:—

"I do not impute dishonourable conduct to any man when I say that I have reason to fear your letters to the three instrument-makers I mentioned have rather tended to increase my difficulty than to lessen it. I have called on two of the gentlemen in question, and have written to the third. In one case I have been told that the extract with which you favour me is not to be found in the reply given to the letter which you stated you had addressed to my informant. In the second case, I am told that the reply given to you was intended to strengthen rather than to weaken my remarks, and that more than one personal experience was narrated by your correspondent in support of my observations. In the third case, my informant writes to admit that when I called on him he said, 'It is not likely that one would like to offend anyone by whom one was employed.'"

And it is worth relating that, after all this, I was introduced by an electrician of the highest standing to a well-known telegraph-instrument maker, who actually declined to carry out any ideas because he also feared to offend the Engineer-in-Chief; but he recommended me to another maker in the strictest confidence, who made the instrument which has sufficed to furnish the interesting results thus far attained.

If any demonstration were needed of the hopelessness of expecting fair play for an outsider from the telegraph authorities, their conduct in reference to the recent Loan Exhibition of Scientific Apparatus at South Kensington would supply it. At that exhibition the Postmaster-General exhibited the instruments which I entrusted to the Post-office for the purpose of the proposed trial. But, although the instruments were exhibited, they were at first omitted from the catalogue and labelled incorrectly. When a second edition of the catalogue was being prepared, I applied to the director of the exhibition for permission to write or revise a description of them. Instead, however, of obtaining such permission, the director, Mr. Cunliffe Owen, replied, "the General Post-office can alone be recognised as the exhibitor of the instruments, and the only description that can be accepted for the catalogue, is that which has been furnished by it." I then applied to the Postmaster-General, who answered by his secretary, that the "labelling and description of the various instruments exhibited had been carried out under the supervision of the authorities of the exhibition, and that his Lordship must refer me to them as regards the labelling and description." I again applied to the director of the exhibition, who answered that the description of the instruments had been furnished to him by the Postmaster-General.

The next instrument to mine in the second edition of the catalogue, numbered 1,564 E, was described as printing the signs transversely. Now it cannot be doubted that this erroneous statement was made by the authority of the Post-office, and might be altered by the same authority. It was manifestly so described to produce the impression that the Post-office had another instrument which would do what mine did. But the authorities of the Post-office would not state this distinctly, because they would then be liable to be asked why, if they had got such an instrument already, they had spent money in trying mine. But, although this statement could not be made, it might be insinuated, and when I challenged the covertly hostile paragraph, I was told that the responsibility for it rested with the officers of the exhibition, who, however, met this assertion of the Post-office with a distinct and positive denial.

The limit necessarily assigned to this article prevents my entering further into this painful question, but I shall be happy to forward a copy of my case as presented by the Secretary of State to her Majesty to any gentleman who may wish to possess it. I will only add in conclusion that upon all points the Post-office has broken faith with me. It promised that there should be a full and fair trial of my system. It invited me to make costly preparation for such trial. It induced me to engage and to pay two eminent scientific gentlemen to represent me at the trial. It arranged and signed terms of reference. It promised to adopt my system if the trial proved satisfactory. It obtained possession of my instruments under a written promise to proceed with the trial. It broke all those promises. It has given no reason for doing so. It has never appointed a meeting of the referees. It has not replied to my application to be reimbursed for the consequent loss of my time and my money. It has neglected to deal with my petition for redress, although such petition has been referred to it by the Crown.

RICHARD HERRING.

The number of visitors to the Paris Exhibition **during the months of May and June were 1,666,879 admissions in May and 2,555,523 in June, the increase in the latter month being due to the fact that the Exhibition and its annexes were not completely ready till the end of May.**

The Lords of the Committee of Council on **Education have determined to award bronze medals to students who obtain a first-class in honours in any subject of science at the May examinations.**

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,346. Vol. XXVI.

FRIDAY, SEPTEMBER 6, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

NATIONAL WATER SUPPLY.

HEALTH AND SEWAGE OF TOWNS.

The Reports of the Congresses on the above subjects have been published in pamphlet form, and each report can be obtained at the Society's House, price 2s.

UNIVERSAL CATALOGUE OF PRINTED BOOKS.

(*Continued from page* 877.)

Second sitting of the Committee; present, Mr. W. Hawes, Deputy-Chairman of Council, in the chair, Sir Henry Cole, K.C.B., Mr. E. C. Tufnell, and Mr. J. A. Youl, C.M.G.

371. Sir Henry Cole said—I have received a letter from Mr. George Bell, giving some estimates of the cost of producing a universal catalogue of English printed books up to the year 1600. He assumes that there may be about 20,000 titles up to that period, and considers that those titles, if it were necessary to collect them, would cost about £500, including editorship. If they were printed according to the specimens they would occupy 3,000 pages. He thinks the printing would cost between £500 and £750, if the latter, making a total cost of £1,250 for the titles of English books up to 1600, which is at the rate of £5 per copy of 250. If 150 copies were subscribed for at £10 per copy, the cost would be more than covered. He thinks that, roughly speaking, printed titles could be produced for £62 10s. per 1,000. He thinks it possible there would be a sale of 150 copies, especially taking into account America, which is forming libraries in many cities, and would regard a catalogue as valuable for indicating their wants as well as registering what they possess. He is of opinion that the British Museum, especially by arrangement with other public libraries, might print at once their titles of new books, instead of writing them out in manifold, as at present, and that, by combination with other libraries, the cost would not be much more for printing than for the writing.

372. Mr. Ernest C. Thomas was introduced, and gave the following evidence. He said—I was for some time librarian at the Oxford Union Society, in 1874 and 1875, and at that time I re-organised our library in connexion with my predecessor, and printed a new catalogue.

373. The Chairman—Have you any clear idea in your own mind as to which is the best way to commence the formation of a catalogue such as is proposed?—It occurred to me that the best course, if the idea is to secure the co-operation of other countries, is to print a simple catalogue of English books, not to undertake an universal catalogue at once. It appeared to me that it would possess some recommendations if you first directed attention to first simply securing a printed "finding list" of books printed in English.

374. To what period?—Beginning with the printed books and coming down, say, possibly to this year.

375. As late as we can make arrangements for?—As late as possible for securing complete returns of books. It takes some time now-a-days for English books to get into a catalogue.

376. Have you thought of the use that could be made of the British Museum catalogue?—The British Museum catalogue would be most useful if you could have full access to it. I do not know how far you would be able to secure that.

377. They have prepared a good deal of it?—But I believe they only possess two catalogues, one inside for their own use, and one for the use of the public in the library.

378. Sir Henry Cole—How many volumes are there in the library of tho Oxford Union, of which you prepared the catalogue?—Roughly, about 24,000 volumes.

379. Was the catalogue printed, and would it be obtainable?—I have no doubt it could be obtained. It is sold to the members. I have no doubt if I sent a note to the librarian you could get a copy.

380. Was that arranged alphabetically?—It was simply an alphabetical catalogue with several indexes.

381. Mr. Foster—Not the full titles?—Simply a finding list. Since then I have taken great interest in bibliography, and have travelled a great deal in Germany on the subject.

382. Sir Henry Cole—Have you made acquaintance with any catalogues in Germany?—I have examined the catalogues at several German University libraries.

383. How was the catalogue of the Oxford Union Library produced? Was it voluntary labour or paid labour?—It was voluntary labour by members of the committee. A copying clerk was employed to copy the titles after they had once been arranged. Then the members of the committee edited it.

384. Did the University printer print it?—No, it was printed by a private printer in Oxford.

385. Do you recollect about what the cost was?—About £50, I think, for 500 copies.

386. That of course included nothing for editorial labour?—That was simply the printer's bill, somewhere between £50 and £60.

387. Did that include the copying clerk?—The catalogue was first prepared by the committee, which met and cut up the old supplements and old catalogues, and pasted them into books, and then finally the arrangement of this was left with the copying clerk, that being merely mechanical labour, and that was again odited by the committee, and printed from that. The copying clerk cost about £5.

388. So that the cost was under £60 altogether?—Yes, I think so.

389. What is it sold for?—I think it is sold to the members at 2s. per copy; of course, with no view of covering the cost.

390. Have you received a specimen of the form in which it was suggested that the universal catalogue should be printed?—No.

391. It was prepared specially for library use, not for the public, so to speak?—That was really prepared for the purpose of being pasted into books for consultation. When you are once printing a catalogue, you may as well print a large number.

392. If you find out that the public want it, you can and provide for both objects; that is, for use in a library, for any one who likes to have it. This specimen was

prepared, not for the public, but for use in libraries—printed in a somewhat expensive form, and proposed to be printed on only one side of the paper.

393. The Chairman—Was yours printed on one side of the paper, or on both ?—On both sides. You used two if you wanted to cut it up. It would increase enormously the expense to print on one side of the paper only, and I would suggest that it would be better to print on both sides, and to have two copies if you wanted to cut it up.

394. Sir Henry Cole—Is the catalogue often kept up ? —It is kept up by supplements. The additions are printed every term, and these are cut up and pasted into books.

395. Do you follow the practice adopted in Dublin; they print a catalogue of one edition containing the additions every year, so that they have the whole library in type printed ?—That is so, except that we print every term—not an edition but supplements.

396. The Chairman—I suppose that is done every term, as an economy of labour ?—Yes, it is the rule.

397. And as a means of getting more correctly the whole amount of literature that appears during the term ?—Quite so; and the great advantage of it is this, you do not need to have manuscript and print in your reference catalogues. Everything there appears in print. The slips are cut up by the library clerk and pasted in.

398. Sir Henry Cole—How many members are there in the Union ?—Of subscribing members about 1,200, I think.

399. You say that 1,200 members keep a printed catalogue constantly going by private enterprise in Oxford ?—Yes.

400. Would you consider that it is beyond the means of this nation to do for its National Library what the 1,200 members of the Oxford Union do for their library ? —No; it appears to me an absurdity that it has not long ago been done.

401. The Chairman—By "means" do you mean pecuniary means or physical ?

402. Sir Henry Cole—I mean by the united energies of learned men, printers, catalogue makers, buyers, the Stationery-office, and the ratepayers, all harmoniously combined, would you consider it possible for their united interests to do what your 1,200 undergraduates have done in Oxford ?—Certainly.

403. Have you applied your mind to the difficulties that have prevented that being done ?—I have thought a great deal about it. I have never quite understood what the difficulties are; I think my own view would be simply that expressed by the late Mr. Dilke in a paper he published in the *Athenæum*, in 1850, that Sir Rowland Hill would soon do it if he were put at the British Museum.

404. Do you consider that there is truth in the proverb in this case that too many cooks spoil the broth ? Do you think that too many cooks do spoil the broth in this case ?—I think the fault of the Museum is rather a fault of this kind, that you put chemists to make the broth; that you have there a number of scholars, and what you want is a number of intelligent clerks.

405. That, no doubt, may conduce to the matter, but do you think that 49 of the most illustrious people in this country are the common-sense instrument for getting a catalogue printed ?—No. I should think not.

406. I believe, now, there may be 50 of the greatest dignitaries of this country, the Archbishop of Canterbury, the Prime Minister, the Lord Chancellor, the Master of the Rolls, the First Lord of the Admiralty, the Home Secretary, and a great number of family trustees, whose property was purchased by the nation, and who remain trustees to look after it, making altogether a list of about 50 of the most distinguished persons that England can boast of. Do you think that a kind of instrument that any man in commerce would employ for doing any piece of work ?—No.

407. The Chairman—They themselves may not be the instrument, but they might get others to do it.

408. Sir Henry Cole—Nobody is responsible for it, and it has not been done. The fault cannot rest with the librarians like Mr. Bullen, who is very anxious, personally, to have his catalogue printed. It is a mere piece of mechanism to get it put into type. Do you think that if the Prime Minister, who is a literary man, made up his mind and felt the necessity, that it could not be put into type ?—I should think there is no doubt about it.

409. You think it would be a reasonable inference that he did not care anything about it ?

410. The Chairman—Is it not possible that the avocations of the Prime Minister may be such that he really has not got time to attend to business of this kind ?

411. Mr. Tufnell—If Mr. Bullen thought it necessary he ought to make a representation to the trustees, and then, if they refused it, they would be responsible; but it ought to be his first duty, if he sees the absolute necessity of it, to make such representations to the governing body, and show how it could be done.

412. Sir Henry Cole—If it should appear that he has made perpetual representations, which were not attended to, then what would be your opinion ?—I should like to point out that Mr. Winter Jones probably is the medium of communication with the trustees, and that Mr. Winter Jones, according to his expressed opinion, is opposed to printing the catalogue, on grounds which, I confess, I cannot quite understand. He said he would undertake to print his catalogue in six weeks, but no one would be able to find the book he wanted. He said the difficulty would be he would have 3,000,000 titles, and you could not find a book. I should have thought the answer was, if people succeed in finding books in a MS. catalogue, it ought not to be more difficult in a printed one.

413. The Chairman—It must be easier to refer to a printed catalogue than one in MS.

414. Mr. Youl—I take it, you think it is Mr. Jones who is the impediment, not the Prime Minister of England ?—I should not like to say that, but he expressed an opinion adverse to a printed catalogue.

415. You think he has more to do with it than the Prime Minister ?—The Prime Minister could hardly be expected to have an opinion on the question, but Mr. Winter Jones might. I refer to his opinions printed in the proceedings of the Conference of Librarians.

416. Sir Henry Cole—In truth, the deficiency of the catalogue of the British Museum is owing to there being no responsibility; it is so divided between the librarian and the trustees, and the Government. We ought to be able to do what was done 50 years ago. There was a printed catalogue of the Museum once. Have you consulted the printed catalogues of the British Museum which have been made from time to time ?—I have a general knowledge of them.

417. Have you consulted them when you have been to the British Museum ?—Yes.

418. You are aware that Mr. Panizzi commenced a catalogue and carried it as far as the middle of the letter A, I think ?—I think he had gone as far as A......rinus.

419. Before that time, as far as my recollection goes, there was a catalogue of some thousand volumes which I should think was printed about 1807; have you ever consulted that ?—I know that.

420. Are you aware of any earlier catalogues than those of the British Museum ?—I am not at the present moment. What you have been speaking of, I think, is the catalogue of the King's Library. There is another catalogue, but I know of none previous to that.

421. Have you anything further to add ?—I should like to say a word or two as to the proposed division of cata-

logues into periods. It seems to me that 1600 is a very arbitrary date. Literary periods do not always shape themselves in accordance with chronology. I should suggest that, if you do break it up into periods, from the beginning of printed books, about 1470 to the accession of Queen Elizabeth in 1558 would be a practical date. Therefore get the Elizabethan literature in one volume, but if you go to 1600 you strike right through the heart of it.

422. **Sir Henry Cole**—We had some evidence from experts the other day, three of them; one said the right period was 1603 for reasons which he gave, another said 1640, and another said it should be 1660; and we are informed that the British Museum had recommended the Treasury to print the titles of the books in the British Museum up to 1640. You say up to 1558?—If I were to take a large period I should say to 1660, but if you wish to divide them into smaller periods, so as to get the earlier printed books together, I should take 1558 as the limit.

423. You do not think it would be expedient to delay doing anything until we had got every book that was printed up to 1877?—Certainly not.

424. There was a unanimous opinion expressed by the experts the other day that it would be most desirable to get the British Museum catalogue printed forthwith; do you concur in that view?—Quite so, and Mr. Winter Jones has admitted the possibility of printing it.

425. What time did he say it could be done in?—In six weeks he said he could print it.

426. I think he was hardly serious?—I think he was seriously discussing the possibility of it. I remember Mr. Dilke's opinion was that you could get your catalogue printed in 24 hours after it was completed in MS.

427. **Sir H. Cole**—That was about 1849 I think, but you are aware that the *Times* newspaper is printed off at the rate of some thousands per hour 20 minutes after Mr. Gladstone has made his speech.

428. **Mr. Youl**—When Mr. Winter Jones made that observation that he could print it in six weeks, I suppose he meant put it in type?—I take it he meant get the catalogue out.

429. **Sir Henry Cole**—Have you anything more to say?—The division of the catalogue into subjects I think would be most important, if it is possible, in addition to the alphabetical finding list. It seems to me that in that way you would be more likely to get the co-operation of special institutions. For instance, the Geographical would give you valuable help in geographical books, and the same with other societies.

430. **The Chairman**—That would be a subsequent operation, after we had got a catalogue.

431. **Sir Henry Cole**—You are quite agreed that we ought to get the material first. Are you agreed also that that should be put into alphabetical order as far as possible, according to the authors?—Yes, I think so.

432. **Mr. Foster**—Authors or subjects? Would you not take the dates of the books?—Authors.

433. **Sir Henry Cole**—The simplest plan of all is the titles. Then, if you want the author, you know he is there. What was proposed was that you should, once for all, get every title; you should then arrange them alphabetically, and, if you like, chronologically, as it is in this specimen. You get it into this shape, in alphabetical order; and, having got it into this shape, then what you have here are the various subjects, *poésie*, *morale*, *philosophie*, and so on. Then the Geographical Society, the Philosophical Society, and the Fiction Society would have nothing to do but to cut this up and make their own catalogue as much as they liked. You seemed to hint that, besides getting the titles substantively, you would print then a classification of the subjects. Here it was contemplated to get the titles of printed literature, having the printing on one side, and leaving anybody to make any special arrangement they thought fit. Of course, if you have to double the titles, you double the whole work, and it is a piece of work which everybody can do for themselves. For instance, in this catalogue of the art books in the South Kensington Museum, three volumes containing the titles are produced and sold, but there has been great difficulty in getting the subjects indexed. I cannot tell what the difficulty is, but for three years it has made no progress.—A scheme which suggested itself to my mind was to have first a "finding list" of short titles.

434. You are now making another proposition; I mean a different proposition to this scheme. This scheme was to take the full titles of every printed book?—I presume you want to get the titles of all English books.

435. The full titles?—With some degree of fullness.

436. The perfect title absolutely in full. There are people who would like to arrange their libraries, and do arrange them, according to the printers' names. It is not unusual for a very learned man to make his arrangement wholly according to the printers' names. There are others who take it chronologically. There are others who take it according to the subject of the books. A friend of mine has 600 editions of Horace, and he wants all his Horaces together. In order to meet the desires of all descriptions of literary people, the simplest plan is to get the titles in full. You cannot have anything more?—You cannot have anything more, but the number of people who care for titles in full is comparatively small.

437. I began by saying that was made for libraries. The people who go to the libraries would do anything they like with it?—Do you not propose to consider at all the class of students who would find it a great convenience to have a list of books by them without being compelled to go to the British Museum so as to consult the catalogue.

438. I should think it not unlikely that, if that universal catalogue were ever made, that every free library in the country would have it, and people could consult it there? —A clergyman could not consult it in his parsonage. The great difficulty seems to me in that case that you would have to print such an enormous number of volumes.

439. Do you accept the idea of having the title of every book that has ever been printed. If you say "No, I do not, because there are too many," that is a different thing. If you ask if this universal catalogue is for a clergyman in his library I should say, no, it is not; but he must go to the free library of the place. If you have once got the titles then you may do anything you like.

(The Committee here had produced to them a folio catalogue of the printed books in the British Museum, printed in 1787, consisting of two volumes bound in one.)

440. **Sir Henry Cole**—It appears that 100 years ago we could get a catalogue?—The increase in the Museum is enormous since then.

441. You would not say the increase of population is a reason for neglecting the care of the population.

442. **Mr. Foster**—If it were a smaller work, then they had not the means of doing such work as we have now? —It seems to me the catalogues you should examine rather than this old museum catalogue is that of the Bibliothèque Nationale, at Paris. They have printed 11 volumes on French History, and the number of volumes catalogued there—I take this from Tacherot's report in 1874—is over 440,000.

443. Is the whole of the catalogue printed?—No, it is not completed; portions of it are printed, History, Medicine, and Theology. I believe it is stopped now for the present. Probably, if you get the last report of the librarian, you would see what has happened.

444. **Mr. Foster**—The thing is to get the matter together in alphabetical order, and then anybody else may do with it what they like?—In considering in what

way you are likely to practically get something useful, it appears to me, with all all due deference, that if you are going to print the titles in full you will immensely increase the difficulty of the undertaking. In the first place, it will take of course much more time and trouble, and then you will sell very much fewer copies. It would be useful for librarians and to bibliographers, but for purposes of consultation it would not be so convenient as a book with shorter titles.

445. **Sir Henry Cole**—Why?—I am putting it in this way. The present Museum catalogue is an immense impediment to people consulting it.

446. Why?—Because you have there over 400 volumes to refer to.

447. If you want to get any particular thing, the volume containing it is legibly labelled. You want to get to C A T; it matters not whether there are 10,000 volumes, supposing you can readily get to C A T. The number of volumes does not affect your consultation?—If it is quite certain that you will find what you want when you get there, but supposing you find a cross reference.

448. Then, supposing you are referred to D O G. You can find the volume with D O G directly. If the volumes were all round this place, it does not confuse your mind that there are 2,000 volumes, any more than with 80,000 titles in a book; you turn to the one you want to consult?—My experience is, if I go to the catalogue and find a cross reference, and have to walk across the semicircle to get another volume, which takes 30 seconds, and if I have many cross references to make and lose 30 seconds every time, it is a matter of importance.

449. **Sir Henry Cole**—When a thing gets so very big as the catalogue of the British Museum has got, you cannot put it into a diamond volume, to put it into your pocket.

450. **Mr. Foster**—The proposition is one which does not involve cross references. The title would never be entered more than once, and you could not get by any chance a cross reference. It would be the material from which you might make up your own catalogue of subjects, or short titles, or anything you please; but there is the material, arranged in the alphabetical order of the authors. It is material for anybody to work with—authors. That is the idea.

451. **Sir Henry Cole**—When you have the material you can treat it in any form you may desire. You cannot get all printed books together; the next to getting the books is the titles of the books. The British Museum has, I believe, 1,250,000 titles of some kinds, including cross references?—I understood Mr. Jones to say there were more than that. In the Bibliothéque Nationale, there are over 2,000,000 of books, counted volume by volume. You propose to put this in alphabetical order.

452. **Sir Henry Cole**—Unless you can suggest anything better?—No, certainly alphabetical order is the best. The only question is this, whether you would break the thing up into subjects, not having one alphabetical arrangement, but a series of alphabets.

453. You mean to bring the subject of chronology or to bring history as the head title, then you would take the alphabetical sub-arrangement. When you have all the titles referring to history up to 1600, what would you do to them?—Put them in alphabetical arrangement.

454. According to the authors?—Yes.

455. You would prefer to take history rather than chronology; for instance, you would not collect all the books of Caxton together? The first book printed by Caxton of which there is any notice in this catalogue is "Herodius: a fiction," which was printed in 1481. The next book was "Christine of Pice" imprinted by Caxton. The next one a book relating to games, the next one Ovid. Instead of having all these books of Caxton together, as in this specimen, I understand you would have separate headings, with poetry, games, proverbs, fiction, history, and so on?—Yes, because the name of the printer is interesting, but it is an interest which only affects a small class of persons; the people who care for special subjects are very numerous.

456. I think that is a suggestion well worthy consideration?—The number of people who care for the book printed is very small.

457. This shows not only who printed it, but it gives you the history of printing for the period, beginning with 1474, 1478, and 1480. From the bibliographical point of view I think there is an interest?—There is an interest, but supposing you do not know the date of the book, you must have a very full index, which is an additional labour.

458. Your leaning would be, having got the titles of the books, to arrange them by subjects?—I think so.

459. I suppose if we had half a dozen people, three would be on one side, and three on the other. Someone said the other day he should be in favour of an arrangement by printers' names?—I think he would be in a minority.

460. I am not sure there is not a great catalogue maker who is strongly in favour of the chronological arrangement, but you are in favour of the classified arrangement?—Yes, because then the public would be able to get at the books required more easily. I presume you do not confine the interest you take in this matter simply to its usefulness for libraries.

461. I suppose when this gets practically to be worked out the demand for it in any kind of shape would be so small that you would only contemplate its being used in public institutions in the main. I should be very much surprised if in any arrangement, chronological, alphabetical, or according to the subject matter, the sale would amount to 150 copies, except to libraries.—I should think that certain sections would sell; the clergymen would buy the sections relating to theology. Then again students of literature would be very likely to buy the section of "Belles Lettres." I would only take a few divisions; I would not go on to subdivide *ad infinitum.*

462. It is only proposed to collect the raw material; to find out the titles of books?—But is it not worth considering when you are collecting the raw material (and you must, in any case, spend a great deal of money in printing it), which is the most useful form in which to print it?

463. I think it is a very fair subject for consideration. I think your argument points out that it would be better to divide it in classes than it would be to take an abstract chronological or mere alphabetical arrangement?—I think the chronological arrangements would be very impracticable.

464. What is proposed here was that the titles up to 1550 should be arranged alphabetically, according to the authors' names. Then everybody might subdivide it as he liked afterwards. The Geographical Society might take the titles relating to geography out of that period, and other societies the same.

The Committee then adjourned.

The import of needles into France is stated to be largely on the increase. The total value for the five years only averaged 1,500,000 frs., but last year it exceeded 2,500,000 frs. The exports of French cutlery now average 2,700,000 frs. in value, whilst the imports do not reach 490,000 frs.

An announcement has been made that it is proposed to hold an international industrial exhibition in Glasgow in 1880, the matter being in the hands of a number of influential citizens headed by the Lord Provost.

MISCELLANEOUS.

CONGRESS OF HYGIENE AT PARIS.

At the instance of the delegates from the Sanitary Institute of Great Britain, the chief managers of the Congress were invited to a public *déjeuner*, at the "Continental Hotel," at the close of the work, to meet a number of the delegates to the Congress from differeut nationalities, to receive from them an expression of their satisfaction at the way in which they had been treated, and the admiration at the manner in which the business of the Congress had been conducted. In the absence of the Duke of Northumberland, the President of the Institute (who had intended to be present at the Congress had his official duties permitted), Mr. Edwin Chadwick, C.B., Vice-President, received the guests. Letters expressing gratification at the invitation, and regret that the remaining business of the Congress prevented their attendance, were read from several of the chief managers of the Congress.

The Chairman said—This has been the largest Congress on the subject that I have yet known, comprising as it does between six and seven hundred members of different nationalities, amongst whom are delegates from remote countries, where we have never heard before of attention being given to public measures for the prevention of excessive disease and premature mortality. The assemblage is one that sheds a light of progress throughout the civilised world. In my position, I feel honoured at the way in which our invitation has been met—when I see by my side M. Guineau de Mussy, the physician to the late royal family of France, whose high accomplishments London society regrets to have lost, but whose science is now being applied to important works for the sanitation of this metropolis. Before me I see M. Pietra Santa, the physician of the late Emperor, of whom whatever else may be said, it cannot be denied that he did much for the sanitation of Paris by removing masses of the "habitations of cruelty," as the Psalmist calls them, and opening up new lines of external ventilation, and this he did, though it was but a first and comparatively easy step in sanitation, for a great amount of more difficult work remains to do, which it is to be hoped the present Government will follow the light of science in doing. I may welcome here, Dr. Sapolini, the distinguished physician of the King of Italy. Most welcome is a delegate from Rome—from Rome, whose dominion over the ancient world was marked by great primitive works of sanitation, by grand storage reservoirs and aqueducts for the distribution of pure water, by public baths, and by cloacæ for the maintenance of the health of cities. Now that Italy is restored as a kingdom, it is to be hoped that she will be restored to her ancient power by such works as barbarism has destroyed and ignorance and sloth have left in ruins! We have had the acknowledgment made by our Premier, that the study of the public health is the first duty of a statesman. I can bear witness that Italy's great statesman, Cavour, had an advanced perception of that duty, manifested by immediate action on his appointment as Minister of Public Works, for he came over to England and did me the honour to pay me a visit at the first General Board of Health to learn what we were doing, and I entered into a communication with him which unhappily was cut short by his removal by political convulsions and by war. Let us hope that statesmanship in Italy has not died in him, but that peace and unity will allow it to be applied to the revival of her pristine relative condition in the world—of health and productive force. I apprehend that an accident has prevented the attendance as our guest of a physician of the Court of Germany, where I know special interest is taken in the subject by the daughter of our Queen; and where, in Berlin, great works that I may attest to be sound in sanitary principle are in progress. Spain, too, puts in her appearance, by eminent physicians who honour the occasion as our guests. Gentlemen, these collective delegations of physicians of the highest position denote the progress of a great change for the benefit of humanity when we see those distinguished minds which have successfully applied that curative science, the only science they were taught in their colleges, to the cultivation and to the promotion of the new science of sanitation; to the new science of prevention, which we are trying to advance by a degree-giving institution. For the future, the prescriptions of the sanitary physician will have to be given not to the *pharmacien*, or the apothecary, but to the builder, the architect, or the engineer. Of the important class of specialists in the new science of sanitation by works, we have present delegations of sanitary engineers, who have made good their pretensions by successful works, and who, in some important specialities, have come not to learn but to teach. The service of sanitation in works will have to be achieved by improvements in details; in which the great will often be found in the little, in things for dealing with conditions that are not merely unattractive but repulsive to high seated ignorance and apathy. I am happy to have near me as one of our present guests M. Charles Joly, the author of the most correct and complete treatise I know of on warming and ventilation, and the inventor of what I believe is the best form of domestic open fire-place, which ventilates by warmed air and by removal of vitiated air. Of our own countrymen we have here a sanitary engineer, Mr. Rogers Field, who, for the sanitation of villages and isolated mansions, has invented a self-acting apparatus or flushing tank, for the immediate removal of all putrescible matter before it can enter into noxious stages of decomposition, and its transference, through permeable drains beneath the soil, for vegetable production. We have here too, Colonel Waring, the most advanced sanitary engineer I know of in the United States of America, who has successfully applied there Mr. Field's invention. This in fact applies to villages and mansions the arterial and venous system which it has been a great object of mine to promote the application of to cities, of bringing in pure water, carrying in a constant supply to every house, and carrying away, by a connected apparatus, constantly and without stagnation and probable decomposition, all fæcal matter by water carriage, and all putrid water, and immediately applying it to the land for agricultural production. We are glad to see here, also, a member of our Council, Dr. de Chaumont, the physician of the Netley Hospital, a centre of army sanitation, who has done good work in the specialities of ventilation, and is the worthy successor of the late lamented Dr. Parkes, the author of the first dictionary on the public health. Gentlemen delegates, it is my duty to greet you one and all as our guests. Time does not permit me the gratification I had wished, of calling upon the delegates of each nationality for an expression of their sentiments, but I expect that I may presume upon your sanction in formulating an expression of our thanks to the French Government, and to the French managers of the Congress for bringing us together, for the way in which we have been received and treated, and for the excellent manner in which they have conducted the business of the Congress. I trust that the acquaintances thus begun will lead to general intercommunication of experiences for the common benefit of populations, in which respect I can assure you of the willing action of the Sanitary Institute of Great Britain, which I have the honour to represent, and I may also add that I speak as delegate of the Society of

Arts of London, of which H.R.H. the Prince of Wales is president.

A vote of thanks was given to the Chairman, and expressions of regard to him as the *Doyen* of Sanitation.

STEERING OF SCREW STEAMERS.

The following is the report of the Committee of the British Association, consisting of James R. Napier, F.R.S., Sir W. Thomson, F.R.S., W. R. Froude, F.R.S., J. T. Bottomley, and Osborne Reynolds, F.R.S., Sec., appointed to investigate the effect of propellers on the steering of vessels.

Since the meeting of the British Association, held in Plymouth last year, this committee has had the satisfaction of receiving reports of the trials of various English and foreign steamers, made by the owners and officers of the steamers, without any further instigation from the committee than that contained in their circulars. These reports all show that those by whom the trials were made have become convinced of the importance of the facts which they have observed. And, indeed, the mere fact of the trials having been undertaken shows that the importance of the effect of the reversed screw on the steering while the ship is stopping herself, is beginning to be recognised. This is further shown by the fact that one of the trials was undertaken at the instance of the Court of Mr. Stipendiary Yorke, in order to ascertain if the captain of the s.s. *Tabor* had been justified in starboarding his helm in order to bring his vessel round to starboard after his screw was reversed.

All these trials, without a single exception, confirm the results obtained in the previous trials made by the committee. But this is not the most important purpose which this year's trials serve. For as regards the general effect of the reversed screw on the action of the rudder, the trials already reported, particularly those of the *Hankow* (see last year's report), are conclusive and leave nothing to be desired. But previous trials were all made with fast vessels at their full draught, their screws being well covered, and the conditions of the weather being most favourable. The trials this year, on the other hand, appear for the most part to have been made with vessels in light trim, and in two instances the wind was blowing with considerable force. The result of these circumstances on the behaviour of the vessels is very decided and coincides remarkably with the effects deduced by Professor Reynolds from his experiments on models (see Report, 1875, i., p. 145), viz., that when the screw is not deeply immersed and froths the water, it exerts, when reversed, considerable influence to turn the vessel independently of the rudder; the vessel turning starboard or port according as the screw is right or left handed, which effect (and this seems to be the point most generally unknown) nearly disappears when the screw is so deeply immersed that it does not churn air into the water.

Neither the Admiralty, the Board of Trade, nor the Elder Brethren of Trinity House have taken any further notice of these results communicated to them by the committee.

The Marine Board of South Shields has, however, taken considerable interest in the question, has invited captains to make trials, and Mr. J. Gillie, the secretary, was present at the trial of the *Tabor*, ordered by the Court, and reported the results to the committee.

There have been numerous collisions during the year, and in almost all cases the practice of reversing the screw has been adhered to. In many, if not all instances where this has been done, the evidence goes to show that the vessel in which the screw was reversed did not turn in the direction in which those in charge of her were endeavouring to turn her. In two important cases this fact was fully apparent even to those in charge of the vessel. And in one instance the owners and captain of vessel attributed the failure to steer to its true cause, namely, the reversal of the screw; although in both cases those immediately in charge of the vessels contended that the rudder was not handled according to their directions.

The first case was that of the *Menelaus* and the pilot schooner on the Mersey. The *Menelaus* was in charge of a first-class pilot, and this steamer in broad daylight, ran into and sank the pilot schooner, which was dropping up the river with the tide. The pilot in charge contended that owing to the wheel chains having got jammed, his orders were not attended to. The jamming of the chains was denied by the owners; and the fact that they subpœnaed the secretary of the committee to give evidence at the trial, may be taken to indicate the cause to which they attributed the collision.

The case, however, was only in part heard, for after the evidence for the plaintiffs a compromise was effected, and pilots withdrew all assertion that the wheel chains had been jammed, thus admitting that the failure to steer had been brought about by the reversal of the screw.

The other case is the well-known accident to the *Kürfurst*. In this case it is admitted that the order was to starboard the helm and reverse the screw of the *König Wilhelm*, and this order was avowedly given with the view of bringing the vessel round to port. All the experiments of this committee, however, go to prove that with a reversed screw and a starboard helm, such a vessel as the *König Wilhelm* would have turned to starboard rather than port. This was what, according to all the evidence, did actually happen, and was the final cause of the catastrophe. But it appears that those in charge of the *König Wilhelm* arrived at the conclusion that the men at the wheel (and these would be many), although they all aver that they heard the order and obeyed it, in reality turned the wheel the wrong way. Considering, therefore, that it was not one man but a number of men at the wheel, and that the vessel behaved exactly as she would have behaved had the order been obeyed, as the men say it was, the conclusion of the Court seems to be most improbable, and for the sake of future steering most unfortunate.

The committee are now of opinion that the work for which they were originally brought together has been fully accomplished. The importance of the effect of the reversed screw on the action of the rudder has been fully established, as well as the nature of its effect completely ascertained. Also, for two years, the committee have urged the results of their work upon the attention of the Admiralty and the various marine boards, and although they regret that, as yet, they have failed to obtain that general recognition of the facts brought to light, which their vital importance demands, they consider that this will surely follow, and that as a committee they can do no more than publish the reports of the trials and the conclusions to which they have been led.

Full accounts of the experiments made previously to this year have been given in the two previous reports, and those which the committee have received this year are given at length at the end of this report. The following is a summary of the conclusions which have been established, and it is interesting to notice that the conclusions drawn by Professor Reynolds, from experiments on models, have been fully confirmed by the experiments on full-sized ships.

Summary of the results of the trials of the effect of the reversed screw on the steering during the time a vessel is stopping herself.

It appears, both from the experiments made by the committee and from other evidence, that the distance required by a screw steamer to bring herself to rest from full speed by the reversal of her screw is independent; or nearly so, of the power of the engines, but depends on the size and build of the ship, and generally lies between

four and six times the ship's length. It is to be borne in mind that it is to the behaviour of the ship during this interval that the following remarks apply :—

The main point the committee have had in view has been to ascertain how far the reversing of the screw, in order to stop a ship, did or did not interfere with the action of the rudder during the interval of stopping, and it is as regards this point that the most important light has been thrown on the question of handling ships. It is found an invariable rule that, during the interval in which a ship is stopping herself by the reversal of her screw, the rudder produces none of its usual effects to turn the ship, but that, under these circumstances, the effect of the rudder, such as it is, is to turn the ship in the opposite direction from that in which she would turn if the screw were going ahead. The magnitude of this reverse effect of the rudder is always feeble, and is different for different ships, and even for the same ship under different conditions of loading.

It also appears from the trials that owing to the feeble influence of the rudder over the ship during the inverval in which she is stopping, she is at the mercy of any other influences that may act upon her. Thus the wind which always exerts an influence to turn the stem (or forward end) of the ship into the wind, but which influence is usually well under the control of the rudder, may when the screw is reversed become paramount and cause the ship to turn in a direction the very opposite of that which is desired. Also, the reversed screw will exercise an iufluence, which increases as the ship's way is diminished, to turn the ship to starboard or port according as it is right or left handed; this being particularly the case when the ships are in light draught.

These several influences, the reversed effect of the rudder, the effect of the wind, and the action of the screw, will determine the course the ship takes during the interval of stopping. They may balance, in which case the ship will go straight on, or any one of three may predominate, and determine the course of the ship.

The utmost effect of these influences when they all act in conjunction, as when the screw is right handed, the helm starboarded, and the wind on the starboard side, is small as compared with the influence of the rudder as it acts when the ship is steaming ahead. In no instance has a ship tried by the committee been able to turn with the screw reversed on a circle of less than double the radius of that on which she would turn when steaming, ahead. So that even if those in charge could govern the direction in which the ship will turn while stopping, she turns but slowly, whereas, in point of fact, those in charge have little or no control over this direction, and, unless they are exceptionally well acquainted with their ship, they will be unable even to predict the direction.

It is easy to see, therefore, that if on approaching danger the screw be reversed, all idea of turning the ship out of the way of the danger must be abandoned. She may turn a little, and those in charge may know in what direction she will turn, or may even, by using the rudder in an adverse manner, be able to influence this direction, but the amount of turning must be small and the direction very uncertain. The question, therefore, as to the advisability of reversing the screw is simply a question as to whether the danger may be better avoided by stopping or by turning. A ship cannot do both with any certainty.

Which of these two courses is the better to follow must depend on the particular circumstances of each particular case ; but the following considerations would appear to show that when the helm is under sufficient command there can seldom be any doubt.

A screw steamship when at full speed requires five lengths, more or less, in which to stop herself; whereas, by using her rudder, and steaming on at full speed ahead, she should be able to turn herself through a quadrant without having advanced five lengths in her original direction. That is to say, a ship can turn a circle of not greater radius than four lengths, more or less (see *Hankow*, *Valetta*, *Barge*),* so that if running at full speed directly on to a straight coast, she should be able to save herself by steaming on ahead and using her rudder after she is too near to save herself by stopping ; and any obliquity in the direction of approach or any limit to the breadth of the object ahead is all to the advantage of turning, but not at all to the advantage of stopping.

There is one consideration, however, with regard to the question of stopping or turning, which must, according to the present custom, often have weight, although there can be but one opinion as to the viciousness of this custom. This consideration is the utter inability of the officers in charge to make any rapid use of their rudder so long as their engines are kept on ahead. It is no uncommon thing for the largest ships to be steered by as few as two men. And the mere fact of the wheel being so arranged that two men have command of the rudder, renders so many turns of the wheel necessary to bring the rudder over that even where ready help is at hand it takes a long time to turn the wheel round and round so as to put a large angle on the rudder.

The result is, that it is often one or two minutues after the order is heard before there is any large angle on the rudder, and of course, under these circumstances, it is absurd to talk of making use of the turning qualities of a ship in case of imergency. The power available to turn the rudder should be proportional to the tonnage of the vessel, and there is no mechanical reason why the rudder of the largest vessel should not be brought hard over in less than 15 seconds from the time the order is given. Had those in charge of steamships efficient control over their rudders, it is probable that much less would be heard of the reversing of the engines in cases of imminent danger.

[The rest of the report consists of the reports of the trials of this year.]

THE TELEPHONE AND THE TORPEDO.

A novel application of the Bell telephone is one which has been made in connection with torpedoes by Captain C. A. M'Evoy, of 18, Adam-street, Adelphi. The torpedoes to which the telephone has been applied are those of the buoyant contact class—that is, floating torpedoes, which are used for the protection of rivers and harbours. These torpedoes are held in position beneath the surface of the water by mooring lines and anchors, and it is necessary to ascertain from time to time that these deadly agents are in active working order. They are, of course, connected with the shore by electric wires, by which they may be exploded. They are also arranged so that they may be exploded electrically by contact with passing vessels. For this latter purpose they are fitted with what is known as a circuit closer, which is placed in the middle of the charge within the torpedo. The testing is ordinarily performed by sending a current of electricity through the torpedo and fuse, but, in order that the fuse may not be fired and the torpedo consequently exploded during the process of testing, an extremely weak current has to be used in connection with a sensitive galvanometer. The consequence is that the indications received are so very delicate that they are not always to be relied on. Now, what Captain M'Evoy does is to supplement the electrical test by the test by sounds, and to this end he incloses an ordinary Bell telephone in each torpedo. The telephone is so placed that the vibrating diaphragm is in a horizontal plane, and upon it are laid a few shot or particles of metal, and these are boxed in. Every motion of the torpedo causes the shot to shift their position upon the face of the diaphragm and to cause a slight noise, which is distinctly heard in the receiving

* B.A. Reports, 1876-1877.

telephone on shore. Thus each torpedo, two or three miles away in the restless waters of a channel, is continually telling the operator on shore of its own condition, in language sometimes excited, according to the state of calmness or agitation of the water at the time. Should the torpedoes be sunk they would lie motionless on the bottom, and the silence of the telephone would indicate the fact of their inoperativeness. The telephones are connected to the ordinary electric wires of the torpedoes, but this does not prevent them being tested in the usual way from the battery on shore. This application, it is hoped, may prove the starting point of a more simple and reliable system of defensive torpedoes than at present exists. It will also doubtless suggest other useful applications of the telephone in the same connection.

NOXIOUS VAPOURS.

The report of the Royal Commission on Noxious Vapours has just been issued. The Commissioners visited the most important seats of the manufactures forming the subject of their inquiry, especially Widnes, Runcorn, St. Helen's, Northwick, Tyneside, Swansea, and the banks of the Thames below the metropolis. They inspected alkali works, cement works, chemical manure works, coke ovens, copper works of all descriptions, glass works, lead works, nickel works, potteries, and salt-works. They received evidence in London, Liverpool, Tynemouth, Newcastle-upon-Tyne, and Swansea with respect to the above-mentioned works from manufacturers, land-owners, farmers, clergymen, and occupiers of houses, lands, and gardens, from land agents, scientific witnesses, medical men, and local officers, and from her Majesty's Inspectors and Sub-Inspectors under the Alkali Acts of 1863 and 1864.

The following is a summary of recommendations made by the Commissioners:—

"That the number of the inspector's visits to each work, and all recorded escapes, with the names of the works in which they occurred, be published in the annual report of the chief inspector; and that the inspectors be empowered to inspect plant, and be required to report defective plant to the chief inspector; such reports to be published.

"That the escape of more than one grain of sulphur in the form of any of its acids contained in one cubit foot of exit gases be made an offence under the Acts.

"That the escape of more than half of a grain of nitrogen in the form of any of its acids contained in one cubit foot of exit gases be made an offence under the Acts.

"That the limitations of acid escapes specified in the above paragraphs shall not apply to the production of sulphuric acid from sulphur gases evolved from the treatment of sulphur compounds, where otherwise the sulphur gases would escape uncondensed into the atmosphere.

"That one cubit foot of exit gases shall mean one cubit foot of exit gases at 60 deg. Fahrenheit and under a barometric pressure corresponding to 30 in.

"That the exit gases shall in each case be collected from the exit flue of the chambers before entering the chimney.

"That the deposit of alkali waste so as to cause a nuisance be made an offence under the Acts.

"That the permitting acid drainage to come into contact with alkali waste or the drainage from alkali waste be made an offence under the Acts.

"That all works in which sulphuric acid is manufactured for sale or use be subjected to inspection under the Alkali Acts, and that the escapes of sulphur and of nitrogen in the form of any of their acids beyond the proportions, and subject to the exception above specified, be made an offence under the Acts.

"That chemical manure works be subjected to inspection, and required to adopt the best practicable means for preventing escapes of noxious or offensive gases.

"That sulphate of ammonia works, tar distilleries, and gas liquor works be subjected to inspection, and required to adopt the best practicable means for preventing escapes of sulphuretted hydrogen.

"That all coke ovens be subjected to inspection; and that all coke ovens erected after the passing of the new Act be required to adopt the best practicable means of preventing escapes of black smoke and for diluting sulphur compounds.

"That on complaint of nuisance or damage established to the satisfaction of the Local Government Board, coke ovens existing at the date of the new Act be required to adopt the best practicable means for preventing escapes of black smoke and for diluting sulphur compounds; a period of three years being allowed for compliance with the requirement.

"That arsenic works, cement works, cobalt works, dry copper works, wet copper works (so far as regards those operations which correspond to those of dry copper works), galvanising works, glass works, lead works, nickel works, potteries where the salt glazing process is carried on, salt works, spelter works, tin-plate works, and works for the manufacture of dyes from coal tar derivatives be placed under the supervision of inspectors appointed under the Act, who should have a power of entry and of inspection; and their proceedings should be reported annually to the Local Government Board.

"That with respect to any of the above-mentioned works, the Local Government Board be empowerd from time to time to fix by provisional order, to be confirmed by Parliament, a standard of escape, or to require the adoption of the best practicable means for preventing escapes.

"In all cases of nuisance and damage alleged to be occasioned by more than one individual, the Court should be clothed with full power of apportioning damages and enforcing contribution, and of awarding costs as among all or any of the alleged contributories to the nuisance or damage."

CHINESE POLYTECHNIC INSTITUTION.

Among the various means which have been devised for the purpose of making the Chinese acquainted with the sciences, arts, and manufactures of the West, the Chinese Polytechnic Institution is considered by Consul Davenport as worthy of special notice. The idea which the originators of this scheme seem to have in view is, undoubtedly, a most excellent and comprehensive one. A reading-room is to be supplied with the files of the various newspapers and periodicals published in the Chinese language. A library is to contain all the important works on technical and scientific subjects that have been written by the natives themselves or translated by foreigners. A lecture-room is to be provided with collections of scientific apparatus suitable for a series of popular lectures on natural philosophy and branches of useful knowledge. And, lastly, a permanent exhibition is to display such specimens of machinery and manufactured goods as foreign manufacturers may feel disposed to send, with the view of creating new wants, and opening up new avenues for commercial enterprise.

When the vast, but undeveloped, natural resources of China, as well as the intellectual stagnation of her hundreds of millions of inhabitants, are taken into consideration, it is easy to see the necessity and importance of an institution of this kind. Consul Davenport observes, the wonder is that such a scheme has not been thought of and carried out years ago, either by those who are interested in the extension of Western manufactures and commerce, or by those philanthropical

societies whose direct aim is the enlightenment and regeneration of China. In order to understand better the object and scope of this institution, it may be well to notice briefly its different branches, and show how each bears upon the advancement of Chinese as well as European interests. With regard to the reading-room, the Chinese have, until lately, been a nation without newspapers or periodicals. The Government organ, called the *Pekin Gazette*, although the oldest publication of the kind in the whole world, is at the same time the most useless, containing merely such memorials and Imperial effusions as it is the interest of the Government to publish for the information of the literary and official classes, and with no organised means for its distribution throughout the country; it is of no use to the masses, who live on, generation after generation, in the grossest ignorance even of their own country, to say nothing of foreign lands and of foreigners generally. During the last ten years, a few enterprising foreigners have been the means of starting Chinese newspapers both in Shanghai and Hong Kong, which are rapidly increasing in circulation and popularity, so much so that the Chinese can now boast of five daily newspapers, while the number of weekly and monthly periodicals is on the increase. The reading-room at the Chinese Polytechnic is regularly supplied with all these journals, while miscellaneous pamphlets are often sent to be laid on the table. Next, as regards the library. Among the standard works of the Chinese, treatises in scientific and technical subjects are not at all deficient in numbers. Before the Jesuit fathers commenced to impart to them the sciences of the West, the Chinese had treatises of their own in mathematics, astronomy, medicine, and kindred subjects, which will bear a favourable comparison with European works of the same date. But these were, of course, in a great measure, eclipsed by the large encyclopædia of works translated by the Jesuits from the best foreign sources. Though long out of date, this collection contains many works that are of much interest, even if of no great value. During the past twenty years foreigners of different nationalities have published above 100 works in Chinese, either translated or compiled from modern European writers, and calculated to make the Chinese acquainted with the present state of western learning. The demand for these is fast increasing, but they are somewhat expensive, so that a Chinaman of ordinary means is hardly in a position to purchase them. At present, the library of the Polytechnic only consists of a few hundred volumes, but it is proposed to enlarge it as soon as sufficient funds are forthcoming.

The first lecture delivered in the institution was illustrated by a series of experiments. It was on electricity, and about fifty or sixty were present. A valuable collection of optical apparatus, presented by Messrs. Bourne and Co., has now arrived, and will form an attractive feature in the proposed lectures. His Majesty, the King of the Belgians, has made the handsome donation of 500 dollars to the institution, which the committee have decided to expend in the purchase of a collection of philosophical apparatus. It may here be mentioned that there is already a demand for scientific apparatus among the wealthier Chinese. It was hoped that some of the large manufacturers of such apparatus in Europe would be induced to present specimens to the institution, with a view to bringing their goods into notice, and thereby extending their business. The permanent exhibition is the only part of the scheme that is not sufficiently matured to make a commencement possible. The vacant land belonging to the institution, and available as the site of a small exhibition building, is about an acre and a half by English measurement. The sum of 5,000 dollars has already been contributed by a wealthy official towards a special fund for the construction of the building. The whole burden has to be defrayed by subscription, and merchants would do well to lend a helping hand, either by liberal subscriptions, or donations of suitable articles. By helping forward this exhibition scheme, manufacturers would be promoting their own interests, and laying the foundation of future demand for the goods they supply.

The Polytechnic was completed, and the building formally inaugurated in June, 1876, but on account of the deficiency of funds and the fact that no active measures were taken to call in more subscriptions, the institution has made but little progress. Without funds the library cannot be enlarged, apparatus cannot be provided, nor courses of lectures kept up. It is somewhat strange that the amount subscribed by Chinese is seven or eight times as much as has been subscribed by foreigners, although the object of the institution is to benefit Chinese and foreigners alike. Nothing is to be expected in the way of pecuniary aid from the Government of China, either imperial or local, at present or in the immediate future. What is wanted is that foreign manufacturers should come to the rescue, and by heartily co-operating with the Shanghai committee or the home committee, enable the institution to arrive at an earlier maturity, and ere long commence a wide career of usefulness in a field more extensive than is to be found in any other portion of the world.

COMMERCE OF ANGORA.

The wealth of the province of Angora is pastoral and agricultural, consisting of mohair, goats, sheep, cereals, &c. Its exports are goats' air, sheeps' wool, opium, yellow berries, and gums. Vice-Consul Gatheral, in his report, states that the commerce of this important district has been much affected by the war between Turkey and Russia. The English demand was nearly an average one, but all the produce of the province has to be forwarded on mule and camel-back over a mountainous country, without roads, distances varying from 200 to 300 miles, in order to reach the sea-coast; and as the military necessities of the Government compelled it to seize these transport animals, in order to provision Kars and Erzeroum, the whole export trade of the province was consequently brought to a standstill for several months. The imports of Manchester and Glasgow goods, colonials, &c., from Europe and Constantinople, usually exceed £100,000 annually; but the constant depreciation of the paper currency nearly ruined this branch of business, and the merchants engaged in it confined themselves to disposing of what they had on hand, many of them closing their places of business altogether.

The British commercial interests involved in this district are of considerable importance. English spinners and merchants are the sole customers for its unique products, and, in normal circumstances, British manufactures would meet with a large and increasing demand. Both exports and imports might be increased tenfold were easy and rapid communication with the sea-coast established. The port road to Ismidt, in the Sea of Marmora, has been allowed to fall into utter ruin, and is almost impassable with mud in winter and dust during the heats of summer. A line of railway was projected from Ismidt to Angora, and was thought to be of such importance that the late Sultan, Abdul Aziz, had resolved to construct it out of his own private revenues; but on his deposition, and during the political troubles that have ensued, this important public work seems to have been forgotten. It had been fully surveyed, and the embankments had made great progress, but these are fast going to ruin also. Were a passable road or a line of railway once established, this province would soon become wealthy and prosperous, not only commercially, but in other respects as well, for the soil is fertile, and the climate being dry, temperate, and healthy, it would offer an attractive field for British colonisation and the investment of British capital.

CORRESPONDENCE.

THE POST-OFFICE AND RECENT ADVANCES IN TELEGRAPHY.

In the *Journal* of August 23rd, was published a paper read by Mr. W. H. Preece, before Section G. of the British Association, at the meeting lately held at Dublin, entitled "Recent Advances in Telegraphy."

The object of this paper, as stated by the author, is to prove, that since the transfer of the telegraphs to the State, this monopoly, instead, as has been publicly stated by very high authorities, of having checked invention in telegraphy and driven it to America, has on the contrary, stimulated invention in this branch of science. Mr. Preece adds that greater improvements have been made in telegrapby in England during the past eight years than in any previous period of similar duration, and that improvement in telegraphy was never more active in England than it has been since the Government has managed the business.

One naturally, as an Englishman, on reading such statements made by a gentleman so well known and highly qualified as Mr. Preece should be to give an opinion, cannot but feel flattered, more especially as from his recent visit to America in an official capacity, Mr. Preece has had every advantage in studying the various systems, and the extension to which telegraphy is at the present day carried in America.

On perusal, however, of Mr. Preece's paper, this feeling of satisfaction gives place to one of disappointment. Instead of baving made good his case, his paper has, on the contrary, but too clearly shown us our own deficiencies, and proved that we have not much to boast of in the way of English original ideas as far as the postal telegraph service is concerned.

Let us take the principal improvements in receiving apparatus mentioned in the paper, viz.:—Varley's and Spagnoletti's induced needles, to remedy the disturbances due to atmospheric electricity; Siemens' direct ink writer, to remedy the irksomeness to the eye of the embossed paper of Morse; Sir W. Thomson's syphon recorder and Varley's condenser, both of these being designed for expediting the rate of working through long submarine cables; Bain's chemical recorder (reproduced after many years interment), for expediting the speed of automatic working through long circuits; Neale's acoustic coil, for assimilating the single needle and bell systems; Bell's telephone, which, however, is employed only on a limited scale in England.

Now it is a curious fact that of these inventions, S. A. Varley's patent was taken out in 1866, Spagnoletti's in 1869, Varley's condenser was patented in 1862; whilst Siemens' instruments, in which ink was substituted for the old plan of embossing, were certainly in use as early as 1858. These dates, as will be seen, are all of them prior to the transfer of telegraphs to the State, which took place at the end of January, 1870. Sir W. Thomson's syphon recorder, patented in 1867—again prior to the transfer—is an instrument for which there is no use in the service. There is not even a cable of sufficient length to be called a cable in the sense of cable working worked by the Post-office, hence of course there is no necessity for employing such an instrument, although I believe one is owned by them, put away in some out-of-the-way room as an ornament. The monopoly, then, can bardly be said to have fostered this invention, or in any way led up to it.

Varley's condensers, as already said, were patented in 1862; they are now largely used in multiplex telegraphy, But their application for this special purpose came from America, as will be seen further on. Also to Mr. Edison, of America, we are indebted for the resuscitation of Bain's chemical recorder, as the instrument had been entirely given up until he came to this country and demonstrated to the Post-office electricians the possibility of employing it as a fast speed instrument. Of the Neale's acoustic coils the system has not been thought sufficiently advantageous by the Post-office electricians to justify its adoption; it is said to have been tried, but apparently did not meet with the approval of the Post-office electricians, as it is not used in the service.

In speaking of the Bell telephone, Mr. Preece himself states further on that it is too sensitive an instrument for practical use in existing lines, and notwithstanding some time has elapsed, it does not appear that any steps have been taken to utilise it.

With respect to sources of electricity, two batteries are named, that of Leclanché and Fuller, but Leclanché's patent was taken out in 1867, and, besides, he is a Frenchman, so unfortunately, the English can hardly lay claim to it, or the Post-office flatter themselves with having had anything to do with the matter. Whereas Fuller's modification of Poggendorf's form of the old bichromate battery is said not to be a sufficient alteration to render his patent valid.

In sources dependent upon motion in a magnetic field we are apparently still more unfortunate; of the three inventors named, viz., Wild, Siemens, and Gramme, Wild is the only one that is an Englishman, his patent dating from 1863, here again prior to the transfer, whilst Siemens is a German, and Gramme a Frenchman. Besides, as Mr. Preece states, no machines depending upon this principle have yet shewn themselves equal in efficiency to batteries for telegraphic purposes.

In sources of electricity dependent on the conversion of heat into electricity, M. Clamond's thermoelectric pile is a purely French invention, it having been brought to this country after it had been perfected in France. We can, therefore, hardly in fairness lay claim to it, as most certainly it was the French that proved that the thermo-pile must in the future be looked upon as something more than the philosophical toy it had hitherto been. Mr. Leonard Wray has, it is true, since the winding up of the Clamond Pile Company in England, with which he was connected, somewhat modified and improved the original form of M. Clamond, but these improvements, Mr. Preece states, have been without any decided results.

In the manufacture of iron wire Mr. Preece mentions that "England stands pre-eminent; Messrs. Johnson, of Manchester, have led the way with their continuous rolling method," and further on he states that "the Americans have adopted Johnson's method of manufacturing iron wire." Here, again, there seems a slight discrepancy, as the continuous rolling method is an American invention, and it is we who have copied the Americans: whilst it must not be lost sight of that at the present time foreign countries are largely supplying the English cable manufacturers with iron wire not only equal in quality, but even in some cases superior, and certainly at a lower price.

The Wheatstone automatic system was a practical success before the transfer of the telegraphs. It can therefore hardly be claimed as an offspring of the Post-office electricians' ingenuity. Why, its very existence at the time the lines were taken over, and the great increase of work consequent on the shilling tariff, was one of the chief things that enabled the Government to so successfully grapple with the difficulty.

It is true that the Wheatstone A B C instrument is a very clever and ingenious piece of mechanism, but as to its being entirely remodelled such a statement appears rather more imaginary than real. It has been altered to a certain extent, but hardly to that degree that Mr. Preece's paper would lead one to suppose; but it is not the only instrument of the class. In France we should be told it did not compare with Breguet's A B C instru-

ment. In Germany we should hear that Siemens' A B C was better, whilst in America there is more than one instrument of a similar class that prints the messages on a slip of paper in Roman type quite as effectual in working as the Wheatstone A B C, which does not print. The Post-office are so far right in employing the instrument for the use of which they have paid so highly. It is, probably, quite equal to any of the others mentioned, and they wisely do not adopt a multiplicity of types of instruments. It is but right to mention this, as from what has been said, one would have inferred that the Wheatstone A B C instrument stood alone of that class.

Further on, a paragraph states "That the distinguishing feature that has characterised the improvements made by the Post-office officials has been in the direction of fast speed telegraphy; and it is not too much to say that they have more than quadruplexed the working 'speed of wires.'" Here we must not overlook the fact that it was Mr. Edison, an American, who came to this country, and by his method of using an adjustable electro-magnet as a shunt with the Bain chemical instrument, successfully demonstrated to the Post-office the possibility of advantageously employing the Bain instrument for high speed working: the difficulty having been hitherto the running together of the signals from induction when high speed was attained. Also, at a still more recent date, we are indebted to America for the duplex system being brought to its present state of perfection. This system was introduced to England by Mr. J. B. Stearns, an American, to whom the Post-office paid a considerable sum for the right of using his invention. Mr. Stearns it was who devised the arrangement of Varley's condensers and resistance coils which have enabled the duplex system to be so successfully used; and in Mr. Preece's own words "made duplex telegraphy a practical success."

Quadruplex telegraphy, Mr. Preece shows, is now being introduced by the Post-office, after having been perfected in America, where on the Western Union telegraph lines it is now applied to sixty circuits. It certainly has not yet reached this state of extension in England.

With regard to what Mr. Preece terms, in his paper, "harmonic telegraphy," Mr. Cromwell Varley does not appear to have been much encouraged by the Post-office in his plan of increasing the capacity of the lines; yet in America (so Mr. Preece states) we find that "it remained for Mr. Elisha Gray, of Chicago, to work the system out practically. This system is now under trial in America, and it is exhibited at the Paris Exhibition, where Mr. Gray is also showing an octoplex system, or a mode of sending eight messages on the same wire at the same time, which is said to have been experimentally tried with success between New York and Philadelphia." Let us trust, therefore, that should the success of this system prove as beneficial as the above statement would lead us to suppose, our Post-office electricians will have the good sense to make use of the invention, whilst, at the same time, they give due credit to the inventor.

Really, when we look at all the points brought forward in the paper to prove the benefit that the monopoly of the telegraph by the State has been, in stimulating invention in England, it does appear that the so-called proofs would be apt to make one believe quite the contrary.

Not one single case has been quoted in which, since the transfer of the telegraphs to the State, one single English invention has been made and introduced into the Postal Telegraph Service. On the other hand, it has been shown that the service has not failed to make use of some valuable American inventions, and these it is, in truth, which have in a great measure assisted the Postal Telegraph Service to its present high state of perfection. At the same time, we must not lose sight of the fact that the Post-office electricians have improved many of the instruments that were in existence when the lines were transferred more especially the Wheatstone automatic instruments as well as the lines themselves, and brought everything into a much more efficient state; modifying existing instruments to suit the requirements of so vast a service as that of the Postal telegraph. After all, this is perhaps the least we could expect of them, as they alone would be in a position to judge of the weakness and roquirements of the service, so far as electrical matters are concerned.

It has been remarked in the paper alluded to, that in England the Morse recorder is now being slowly replaced by the simpler sounder, the principal instrument for many years past in use in America. A curious statement is said to have been made by a well-known American electrician, a short time since. He said, "You English have adopted the sounder from us, but have pitched upon one of its worst forms as your pattern." This statement, whether true or not, seems to be in some measure borne out by the fact, that since Mr. Preece's return from America an entirely new pattern (American) sounder is being constructed, which one learns is to take the place of the old form, and is to be the English type for the future.

Take a number of the telegraph instruments of late construction used in the service, more especially such as are used for fast-speed sending; they are as near a copy of American designs as possible. Let them only have American shaped terminals, the brass work nickel plated instead of lacquered, and fix them upon a rather more ornamental base, and one would hardly recognise them from the originals.

In the list of patents for improvements in telegraphy we find published in Mr. Preece's paper, it is shown that whereas for the eight years prior to the transfer, the yearly average was $48\frac{1}{4}$ patents, that for the last eight amounted to $52\frac{1}{4}$. This increase of some 7 per cent. hardly strikes one as being very great, when we take into consideration the large increase in the telegraph stated to have taken place outside that of the Government, which is said to be as great now as the whole telegraph system of the country was before the transfer. Besides, now-a-days, a foreigner no sooner takes out a patent in his own country, than he also patents his invention in England, especially such as touch upon electrical matters. Then, again, look at the number of domestic applications for which electricity is now coming into use, which, eight years ago, were not so much as thought of.

Next, take the statement made, that—"It is, perhaps, in improvements in conductors that England has shone most; she has supplied the world with cables." For such improvements, surely Mr. Preece would not wish us to infer that they have been caused by the Government monopoly of the telegraphs. On the contrary, one would far more readily suppose that it was the competition that exists between the various cable companies that has brought about these improvements.

Vast improvements have, without doubt, of late years been made in England in submarine telegraphy, both in the manufacture of cables and that of instruments whether for testing or signalling purposes, but one would be inclined to look to the existing competition in this branch, rather than the Postal telegraph service as having effected it.

The following paragraph speaks for itself:—"In 1868, the Western Union Telegraph Company, feeling that their telegraph system was not up to the requirements of the age, secured the valuable services of Mr. Cromwell Varley, who educated them up to the European standard of electrical knowledge, and they have certainly bettered the instruction." From this, one would infer that, about a year or so before the transfer, America was behind England in telegraph matters, yet from that date to the present time America appears certainly to have profited by Mr. Varley's tuition. Some of the most valuable improvements of late years, viz., those of multiplex telegraphy, have come to us

from America. These are inventions essentially brought about by competition, and not monopoly. Now, in the same space of time. Mr. Preece fails to show us what we can boast of, with the exception of having copied America, although at the start it must be remembered we were already ahead of them in electrical knowledge.

Towards the close of Mr. Preece's paper appears a paragraph, which, if true, must be highly flattering to the English nation; it states:—"The fact remains that telegraphy, whether for commercial or railway purposes, is more highly developed in England than in any other country, not excepting America, and this development is due as much to the action of the State in purchasing and managing the commercial system of the country, as to the competition that remains between nation and nation, and between company and company."

It is easy to make such a statement, but quite another thing to prove it. In England we have a really well organised telegraph system as far as commercial messages are concerned. We have not failed to make use, it is true, of foreign experience as well as own, and from this, in a commercial point of view, we must reap a benefit. We have a system of private wires rented at fair prices, and maintained in efficient working order throughout the country. This, then, is the high state of development that the monopoly of the telegraphs has brought about. Such a system as fire-alarm telegraphs has not yet been instituted in England. In speaking of fire-alarm telegraphs it must be understood, that what is alluded to is not a simple telegraph wire and instrument connecting certain fire-engine stations, as at present exists, but a thoroughly organised system, whereby, in case of a fire occuring, by means of instruments placed at certain intervals throughout a town, a policeman or other person may, by pressing a button or some such arrangement, start the automatic apparatus, which will then telegraph to the nearest station, thus giving the alarm, and indicating the spot at which the engines are required; this information, received at the central station, in its turn can then be simultaneously, if required, communicated to any number of stations. Both in America and on the Continent, fire-alarm telegraphs have been successfully at work for some time, more especially in the former instance, where the system has been brought to a high state of perfection. Then, again, have we anything like the American plan of distributing news now at work in some of their large cities, where, by the payment of a small annual rental, an automatic instrument is put up in your place of business, connected to a central office, through which, from time to time, the current news of the day is distributed. The message is printed in Roman characters on a slip of paper in the instrument, without need of any control on your part. Thus, by simply taking up the slip, you may see printed before you the latest news. The system is worked by some of the neatest instruments in a mechanical point of view yet invented for telegraph purposes. Nor have we the American Stock Exchange telegraph, where quotations of the stocks are circulated to subscribers entirely automatically. This latter we certainly have to a limited extent in connexion with the London Stock Exchange. It is, however, worked by the Exchange Telegraph Company and not by the Post-office. The extent of the system is limited, as the Post-office authorities will only permit the company to work within a very few hundred yards radius from the Exchange. This and other difficulties put in their way by the Post-office, has in a great measure prevented its extension. The instruments used by the company are purely American inventions, England not yet having invented an instrument capable of meeting such requirements.

With regard to our cable companies and electric systems as applied to railway working, we surpass all other nations; but here the question of competition is in full force, and these advances must be looked upon as having been brought about by the existing competition rather than from any monopoly owned by the State.

It may be asked in what way the Post-office can be blamed for not having instituted some system of fire-alarm telegraphs, as surely this was a matter for the Board of Works and town councils to take up. In answer to this, it must be remembered that these public bodies look to the Post-office for guidance in such matters, whilst the Post-office do not seem inclined to recommend a system. Then, again, private enterprise can do little in the way of private telegraphs in instituting a plan of distributing news or any similar system, as may be seen from the difficulties experienced by the Exchange Telegraph Company in even trying to extend their field of operations. And, further, this jealousness, if we may so call it, seems to be borne out by the attempts lately made by them of quietly getting a Bill through Parliament, which Bill would have enabled them to retain the entire monopoly and control of all private wires throughout the kingdom. Thus no private individuals would have been in future permitted even to erect a line of telegraph between, say, his works and place of business, or even own such a line. This would certainly have put a stop even to the chance of private enterprise.

The object of this communication is not in any way to throw blame on the postal authorities for their apathy in not establishing some such telegraphic systems as have been mentioned, but rather to show in their true light how the various points mentioned in the paper alluded to really stand. Private enterprise might still do much, and we ourselves are quite as much to blame in the matter. As an instance of this, we need not seek further than that of the telephone. Mr. Preece informs us it has not yet been employed in England other than on a very limited scale, whilst we learn from America that the Americans already have some thousands at work with a system of wires erected expressly for them in connexion with a central office, by which means such as have utilised the system are enabled to converse with each other as required. The following paragraph from the *Telegraph Journal* of August 15th, will give some idea of the extent to which they are used in America:—"Under the American patents some 14,000 telephones have, during the past year, been installed in the United States, and are being rented at an average rental of £10 per annum; and fresh orders are being received at the rate of 1,000 sets per month." Unfortunately, however, in England we are slow to take up new inventions, resting contented with such flattering remarks (on a subject unfamiliar to many of us) upon the high advanced state of the English postal telegraph service as may be made to us from time to time by scientific lecturers and experts like Mr. Preece.

Mention has been made in Mr. Preece's paper of the vast extension to which the present telegraph system has been developed; and no doubt we have arrived at a higher state of development than had the telegraphs remained in the hands of the old companies. The Government, on taking over the telegraphs, were in a position to effect far more, by way of extension, than any private enterprise could possibly do. They already possessed a thoroughly well-organised postal service, in connection with which the telegraphs were to be worked. In many towns which the telegraph had not then reached, postal communication was in efficient working order, so that where, with the old companies, it would not have paid, in a commercial sense, to establish an office and clerks, with the Post-office the office already existed, and the then Post-office *employés* soon found it a *sine quâ non* that they must be acquainted with the manipulation of the telegraph instruments.

Yet, while acknowledging the great extension of the telegraphs made by the Government, it should be mentioned that this extension would not have now reached its present size, had it not been for the great activity of Mr. Scudamore, who stole a march on the Chancellor of the Exchequer, and secured for the public that rapid and vast extension, which, if all official forms

and red tape had been strictly adhered to, we might still have been seeking in the future.

In conclusion, we ought all to thank Mr. Preece for his very able paper, which, if it has not substantiated the proofs of the benefit to be derived from a Government monopoly of the telegraphs in stimulating invention, has, on the other hand, pretty clearly demonstrated to us our backwardness on these points. Let us hope that, for the future, this lesson may not be thrown away.

A TELEGRAPH ENGINEER.

OPEN-MOUTHED PIPES *VERSUS* VENTILATORS.

As you have, at the request of Mr. Buchau, published what he calls "Results showing the effect the shape of the outlet has upon the speed of the up-current," I must request you, as he has referred prejudicially to my cowl, to give the enclosed, being results obtained by the Metropolitan Board of Works, a place in your *Journal* also.

Plain, open, and trumpet-mouthed pipes have been tried so long and so often, and have been found so inefficient for the practical purposes of proper ventilation, that for that object they will still probably be generally considered as out of court.

Not to put too fine a point upon it, I think it is not quite right that Mr. Buchan should have published his results without informing us of the "conditions"—the chief "conditions"—under which he carried out his experiments at Glasgow, which, from the results obtained, seem to have been the duplicate of those at Kew.

By the only two ventilators which he tested, a Boyle's 10-inch soil-pipe (fixed) ventilator was pitted against a 3-inch Banner cowl. The area for exit of air in the Boyle 10-inch ventilator, "with 3-inch pipe attached put on," is as 9 to 6 as compared with a 3-inch Banner cowl—the latter really being (in proportion) not more than $2\frac{1}{4}$ inch—and as 16 to 6 as compared with the plain open 4-inch pipe; while further, according to Mr. Buchan's diagram, the "trumpet-mouthed" and "Boyle" were placed much higher above the ridge than the Banner cowl was.

It has further to be noted, as somewhat extraordinary, that at every one of the nine tests made by Mr Buchan with the plain open pipe, the trumpet-mouthed pipe, and the Boyle fixed 10-inch ventilator, the results obtained gave exactly in every case so many hundreds of feet per minute, while the heavily handicapped little Banner 3-inch (so called) cowl had its results given in tens of feet. I shall leave lovers of fair play to work out the rest.

E. GREGSON BANNER.

11, Billiter-square, E.C., London, 19th August, 1878.

The following are the results attained by Metropolitan Board of Works:—

May 18, 1876.—At Greenwich, through a drain of 100 feet in length, of 4-inch stoneware pipes placed round the yard, and led into a brick shaft 14 inches by 9 inches, on the top of which the cowls were fixed:—

	Temperature. In yard.	Temperature. In sewer.
Wind was east, light and variable....	55	52

		Feet per minute.
1st Test.	The Banner cowl gave a constant up-current of	400
2nd ,,	Ditto ditto	600
	Total	1,000

		Currents. Up.	Down.	Total Up.
1st Test.	The open pipe in shaft gave	57	25	32
2nd ,,	Not made............	—	—	—
1st Test.	The lobster-back cowl gave	150	5	145
2nd ,,	The current intermittent—result........	—	—	200
				345

June 15, 1876.—At Rotherhithe:—

	Temperature. In Sewer.	In Open.
Wind SW. Velocity 10 miles	64	70

Readings of five minutes each.

		Currents. Up.	Down.	Total. Up.
1st Test.	Open pipe gave.......	520	—	470
2nd ,,	Ditto	400	450	
1st Test.	Lobster-back cowl gave	350	230	120
2nd ,,	Not made			
1st Test.	The Banner cowl gave	550		1,270
2nd ,,	Ditto.	720		

Dec. 7, 1877.—At Rotherhithe:—Time of test, 10.40 to 12 noon.

Wind SW. Velocity at 10.40; feet per minute, 528; at noon, 792.

Temperatures, 54 in sewer, 48 in yard.

No. of Minutes of Test.	Open Pipe, no Cowl.	Weaver's Cowl.	Scott's Cowl.	Down Draught into Sewer.
1	nil	nil	nil	100
5	nil	nil	30	
10	nil	nil	100	
1	nil	nil	20	210
5	nil	nil	30	
10	8	8	60	

Experiments with anemometer, showing currents of air passing up 6-inch shafts.

March 8, 1878.—At Ravensbourne-street, Greenwich.

Wind NW. Speed of Wind, 1,160 feet per minute.

Temperature in sewer, 56; in open air, 55.

Time of Observation.	Time of Observing.	No Cowl on.	Banner Cowl on.	Scott Cowl on.	Weaver Cowl on.
A.M.	Minutes.				
10.20	1	242	540	500	260
to					
1.15 P.M.	5	1,640	2,140	1,800	1,200

Showing a difference in twenty-four hours:—

	In Feet.
Between the open pipe and Banner cowl	144,000
,, Scott cowl and Banner cowl....	97,920
,, Weaver cowl and Banner cowl	270,720

To state that the Banner cowl has but little exhaust force is to certify that the Gifford injector and treble nozzle tuyere are shams.

CEYLON COCOA.

Some time has passed since any reference to progress in cultivation of cocoa in Ceylon has appeared. Two and a half years ago several bags of it reached the London market, and fetched a fair price. Are the growers of it in the island aware that now is their time,

for prices have enhanced from 25 to even 75 per cent., according to the kind? This rise in values results from the all but total failure of the Guagaquil crop, and such prices as now obtain have not been surpassed for a quarter of a century. Hoping this may draw attention to the opportunity.

Hahnemann Epps.

London Athenæum, Suffolk-street, Pall-mall, S.W.

GENERAL NOTES.

Whitworth Scholarships.—The following is a notice issued from the Science and Art Department of the Committee of Council on Education, South Kensington:—"Sir Joseph Whitworth having expressed a desire that some important alterations should be made in the conditions of his Scholarships, the detailed rules for carrying out his wishes are now under consideration. They will be published as soon as possible. But in order to prevent disappointment this notice is given. No important changes will be made in the conditions of the *competitive examination* in May, 1879. But the conditions of the tenure, and of the amount, of the Scholarships may be somewhat modified."

The Ronalds Catalogue.—The Society of Engineers is about to publish the catalogue of books and papers on electricity and magnetism, compiled by the late Sir Francis Ronalds. This catalogue, which contains more than 12,000 entries, and will probably extend to over 600 pages, is believed to include every important work and almost every paper which has been published upon the subject of electricity and magnetism up to the date of its author's death in 1873. Sir Francis Ronalds devoted the greater part of his lifetime to its compilation and to the formation of the "Ronalds" Library, now in the possession of this Society. It is proposed, should the number of subscribers be sufficient to cover the extra cost for printing, &c., to issue a separate librarian's edition, printed on one side of the paper only, for the use of librarians. The price to subscribers of each copy in this form will be 20s. The price of the catalogue in the ordinary form will be 16s.

Mining and Metallurgical Statistics.—The following statistics relating to metallurgical interests are given in the preface to Messrs. Kelly's new "Engineering Directory." The total number of collieries, mines, and pits classed under carboniferous and metalliferous mines amount to over 5,000; in which total, however, is included a number of fire-clay, limestone, purbeck, and various other workings, which, perhaps, hardly come under the category of mines. The principal mines are:—Coal, 3,722; iron and ironstone, 600; lead, 390; copper, 80; tin, 103; zinc, 11; iron pyrites, 35; barytes, 25. The number of persons, male and females, employed as miners above and below ground, according to the returns issued for the year 1877, was 494,391. Of these 57,395 were employed in and about the metalliferous mines, the remainder thus:—Coal miners, 268,091; copper miners, 3,063; tin miners, 10,617; lead miners, 14,563; iron miners, 20,930; undefined, 38,712. Outside the ranks of the miners proper are the following:—Workers and dealers in coal, 68,860; ditto in copper, 5,758; ditto in tin, quicksilver, 26,199; ditto in zinc, 1,728; ditto in lead and antimony, 3,729; ditto in brass and other mixed metals, 54,366; and ditto in iron and steel, 360,356. Taken from another and slightly varied point of view, the statistics as to the number of persons employed in each particular branch of the leading metallic manufacturers read thus:—Iron and steel, 341,965; copper, 3,289; coppersmiths, 2,295; brass manufacturers, braziers, &c., 20,930; locksmiths, bellhangers, &c., 7,154; gasfitters, 8,615; wireworkers, 7,436. These are still further particularised in the "occupations of the people" as under:—Engine and machinemakers, 106,437; spinning, weaving ditto, 9,668; agricultural implement ditto, 3,617; millwrights, 7,538; tool makers and dealers, 7,453; file ditto (including females), 9,001; saw ditto, 1,930; cutlers, 17,066; whitesmiths, 8,588; blacksmiths, 112,035; nail manufacturers (including females), 23,231; anchor smiths, 4,163.

The Phonograph.—The researches now being made by help of the phonograph and phonautograph, into the vibrations of speech, and the visible form of sound waves, should result in a typical or general form, and Mr. J. Munro suggests that phonographic type should be cast of all the phonographic syllables used in speech, so that a phonograph matrix might be composed as a printer's page is now composed. With these phonographic characters there would be no need to speak into a phonograph, and multiply the record by electro-typing (unless individual peculiarities of speech were to be preserved), since the type could be set up mechanically. In this way very powerful phonographs, giving loud articulations of what may be called ideal speech, would be practicable.—*Telegraph Journal.*

The Wool Product of the World.—An American paper estimates the number of sheep in the world at from 484,000,000 to 600,000,000, of which the United States has about 36,000,000, and Great Britain the same number. From 1801 to 1875 the wool olip of Great Britain and Ireland increased from 94,000,000 to 325,000,000 lbs. That of France has increased almost as rapidly, although the wool is finer, as a rule, and hence the superiority of French cloths. Australia produces nearly as much wool as the parent country—Great Britain. The United States product increased from very little at the beginning of the century to about 200,000,000 lbs. at the present time. Of this California has produced about one-fourth, and the Pacific coast as a whole almost one-third. The wool clip of Australia is about 284 000,000 lbs.; that of Buenos Ayres and the River Plata, 222,500,000 lbs.; other countries not previously given, 463,000,000 lbs. The total clip of the world last year was about 1,497,500,000 lbs., worth 150,000,000 dols. This when scoured would yield about 852,000,000 lbs. of clean wool.

Paper Exhibition at Berlin.—The exhibition of paper recently opened in Berlin is noticed as being very instructive in the variety of its exhibits. Writing and printing papers, including wall paper, of course, make up the bulk of the manufactures exhibited; but accustomed as are most people to see paper employed for very various purposes, there are yet many applications new to most visitors at this special exhibition. Materials for house building, furniture, railway wheel bodies, boats, utensils for many purposes, and ornaments are among the number. The greatest quantity of paper is used in the United States, and the smallest quantity in Scandinavia. Italy's consumption is small, but that of Russia is very much less, as might have been expected from the condition of her people, form of government, and state of manufactures. The very large quantity used in America is of course principally due to the manufacturing character of a large proportion of its inhabitants. The quantities used per head of population in the principal countries are given in the exhibition catalogue as follows:—United States, 30·8 lbs.; Germany, 13·2 lbs.; England, 11·0 lbs.; France, 7·92 lbs.; Austria-Hungary, 5·5 lbs.; Russia, 1·98 lbs.; Italy, 3·08 lbs.; Scandinavia, 1·1 lb.; Belgium, 11·22 lbs.; Switzerland, 13·86 lbs. The quantity used by the Spaniards is not given, but as Italy's consumption is so small, the influences at work in each country probably reduce the consumption in the former country to an unnoticeable quantity. China is not mentioned, but it is stated that 600,000,000 people use Chinese paper, 366,000,000 use European paper, and 130,000,000 Arabian, 24,000,000 write on leaves, &c., and 280,000,000 are happy without any paper or writing material. The number of exhibitors was upwards of 487, and they comprised among them makers from every European State, and the exhibits included the productions from China and Japan, which form part of the collection belonging to the Museum of Art and Industry in Berlin. The whole of the processes connected with paper-making were shown. Among the exhibits was a small house, the body of which was built of wood, but covered with paper bricks, capable of withstanding wind and weather, cool in summer and warm in winter. The roofing was of paper, as also the wainscot of the interior. The whole of the fittings and hangings inside were of the same material, and the furniture was composed of papier-maché, used in the place of wood. Vases capable of containing liquids, tablecloths and table napkins were also shown, as well as some petticoats and over skirts of the latest fashion all made of paper. A sailing vessel of the same material was exhibited, and an ape copied from that in the Zoological Gardens of Dresden.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,347. Vol. XXVI.

FRIDAY, SEPTEMBER 13, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

NATIONAL WATER SUPPLY.
HEALTH AND SEWAGE OF TOWNS.

The Reports of the Congresses on the above subjects have been published in pamphlet form, and each report can be obtained at the Society's House, price 2s.

GROSVENOR HOUSE.

The Duke of Westminster is desirous that designers, artisans, and the like, employed in any branch of Art applied to productive industry, should have the opportunity of inspecting Grosvenor House, with its Works of Art, daily, including Sundays, during the months of August and September, 1878, from 2 p.m. to 6 p.m. He regrets that, for want of room, he cannot extend the admission beyond the persons specified.

A number of tickets of admission have been placed in the hands of the Secretary of the Society, for distribution among persons answering to the above description.

Such persons can obtain tickets on application at the Society's house, by bringing with them a paper containing their names, addresses, and occupations.

Each ticket admits a party of four.

There will be no admission on wet afternoons.

SOCIETY OF ARTS' MUSICAL SCHOLARSHIPS.

Notice is hereby given, that a competitive examination will shortly be held for one of the Society's Scholarships, now vacant, at the National Training School for Music.

The following are the rules for the admission of Candidates to compete:—

1. A competition for one Scholarship will take place during the present month (September, 1878).

2. Candidates to compete must be nominated by a Member of the Society of Arts, each Member having the privilege of nominating a Candidate.

3. The nomination must be made on the form, and in the terms given below. Copies of the form for this purpose will be supplied to Members on application to the Secretary of the Society of Arts. The Candidate's age must not exceed 20 years. A violinist will be preferred.

4. The examination of the competing Candidate will take place at the Training School. The date, when fixed, will be notified to each Candidate properly nominated.

5. The subjects in which the Candidates will be examined in the competition are as follows:—

a. Reading aloud and recitation with clearness of pronunciation; writing legibly from dictation.

b. Elementary knowledge of musical notation and knowledge of the principles of music.

c. Performance on some instrument or singing (at sight also if possible) or composition.

6. The attention of Members is specially drawn to the foregoing requirements, and it is particularly requested that they will exercise great care to nominate those only who they feel assured can fairly fulfil them.

7. Members nominating must send in to the Society of Arts with each nomination form—

a. A certificate from some one of recognised musical position, showing that the Candidate is qualified to compete.

b. A medical certificate showing that the Candidate is in good health, and has no defect which would impede the practice of vocal or instrumental music.

c. The copy of a register of birth.

d. The certificate of two well-known persons in a locality that he, or she, is of good moral character.

8. Previous to the competition an examination fee of 5s. must be paid by the competitor to the Society of Arts.

9. Admission to the School after Competition.—After a Candidate has been successful in a competition, and has been named for a Scholarship, he or she will be admitted to the Training School upon the production of the above-mentioned necessary certificates of proficiency, health, birth, and character; and his or her continuance as a Student in the Training School will depend on the report of progress by the Examiners and the Director of Studies.

Note.—*On admission the Student will be required to furnish the statement from the Society of Arts Examiner as to his or her capacity, previous musical studies, and antecedents.*

10. The Scholarships confer the right of obtaining the best musical instruction in the School without payments of any kind, either as fees, or for instruments, music, or books, which are provided for use in the School. The School does not provide board or lodging.

11. The nomination paper for the competition, duly filled in and signed by the Member nominating, accompanied with the necessary certificates, and the Candidate's fee, must be sent in to the Secretary of the Society of Arts, John-street, Adelphi, London, W.C., on or before the 21st September, 1878.

(By Order),
P. Le Neve Foster, Secretary.

September, 1878.

The following is the form of nomination:—

Society for the Encouragement of Arts, Manufactures, and Commerce,

John-street, Adelphi, London, W.C.

NATIONAL TRAINING SCHOOL FOR MUSIC.

I, the undersigned Member of the Society of Arts, hereby nominate

Name ....
Age ....
Address ....

as a Candidate qualified to compete for a Scholarship.

Member's signature ....
Address ....
Date ....

SOCIETY OF ARTS MUSICAL EDUCATION COMMITTEE.—H.R.H. the Duke of Edinburgh, K.G.; E. A. Bowring, C.B.; Lord Alfred S. Churchill, or Chairman of Council for the time being; Frederic Clay; A. S. Cole; Sir Henry Cole, K.C.B.; Lieut.-Col. Donnelly, R.E.; C. J. Freake; C. L. Gruneisen; Right Hon. Lord Hampton, F.R.S.; W. Hawes, F.G.S.; Sir H. A. Hunt, C.B.; Right Hon. Lord Henry G. Lennox, M.P.; Frank Morrison; Admiral the Right Hon. Lord Clarence Paget, K.C.B.; Major-General H. Y. D. Scott, C.B., F.R.S.; E. C. Tufnell.

COMMITTEE OF MANAGEMENT.—H.R.H. the Duke of Edinburgh, K.G., Chairman; H.R.H. the Prince Christian, K.G.; the Right Hon. the Lord Mayor of London (for the time being); Viscount Newry; Admiral the Right Hon. Lord Clarence Paget, K.C,B.; Lord Alfred Churchill (or Chairman of the Council of the Society of Arts for the time being); Sir William Anderson, K.C.B.; Sir Henry Cole, K.C.B.; Alan S. Cole, Honorary Secretary.

PROFESSIONAL EXAMINERS.—Sir Michael Costa; Sir Julius Benedict; Sir George Elvey; Professor Ella; Charles Hallé; John Hullah.

UNION OF INSTITUTIONS.

The following Institution has been added to the Union since the last announcement:—

Liverpool Young Men's Christian Association.

MISCELLANEOUS.

THE EXHIBITION OF 1851.

The following letter has been addressed to Mr. Joseph Chamberlain, M.P., as a reply to the deputation of provincial municipal representatives which attended the meeting of the Royal Commission at Marlborough-house, on the 20th of July, 1877:—

"Office of Her Majesty's Commissioners for the
"Exhibition of 1851, 2, Victoria-street, S.W.,
"August 28th, 1878.

"SIR,—I am directed by Her Majesty's Commissioners for the Exhibition of 1851 to inform you that, since they had the pleasure of meeting the deputation of provincial municipal representatives which attended their meeting at Marlborough-house on the 20th of July, 1877, and which was introduced to them by you, they have reviewed the measures which they had at that time resolved to adopt.

"These measures were, briefly, to keep in their hands the bulk of that portion of their freehold property which is at present occupied by the Horticultural Gardens and the Exhibition Galleries, with the object of providing sites for future institutions for the promotion of education in science and art, and to dispose of the remainder of their estate as building land. With the aid of the fund, or income, thus obtained, they proposed to erect, at a cost of £100,000, a building suitable for a science museum and library, and to offer it to the Government to be used for that purpose; and with a further portion of such fund, or income, the Commissioners proposed to establish scholarships to enable promising students in science classes throughout the country to complete their studies in the provincial colleges of science, or in the similar institutions of the metropolis.

"In opposition to these measures, the deputation expressed their view that the proper policy of the Commissioners would be (1) to realise the funds of the Commission to as great an extent as may be possible; (2) to apply the realised funds in grants (*a*) to provincial museums for building, and (*b*) for the purchase of suitable objects for exhibition therein. You explained, at the same time, that the proposed realisation would imply selling that portion of the Commissioners' property which at present produces nothing.

"In reply to the suggestions of the deputation, I am directed to make the following observations:—

"The Commissioners consider that the proposal to capitalise the whole of their property cannot be entertained, because, apart from other reasons, it would clearly be at variance with the appropriation of the land originally contemplated, and a reversal of the whole past policy of their body. The object with which, under the guidance of the Prince Consort, they purchased their estate, was to provide a remedy for the want so often felt in this country of an extensive site for the development of great institutions for the promotion of industrial art and science among the manufacturing population. The South Kensington Museum and the new Museum of Natural History are two great monuments of the produce of the course adopted.

"The Commissioners are confirmed in their view of the wisdom of this course by the memorials, praying for the establishment of a central institution of Arts and Manufactures, which were presented to them in 1852 (when the question of the disposal of the surplus of the Exhibition of 1851 first arose) from the towns of Birmingham, Bristol, Halifax, Hull, Oldham, and Sheffield, and from the Staffordshire Potteries. As the Commissioners remarked in their Report published at that time, these memorials 'indicate clearly the strong feeling entertained by those well entitled to form an opinion on this subject of the importance of establishments for instructing those engaged in trade and manufacture in the principles of science and art on which their respective industries depend.'

"With respect to the mode in which the Commissioners propose to apply the surplus which will result from the sale of a portion of their property, they were led to their conclusions on the following grounds:—

"They have seen with satisfaction that, on the portion of their estate immediately opposite the main square, the Government had erected, in connexion with the South Kensington Museum, a School of Science, largely fed by scholars from the provinces, who had the advantage of studying in practical laboratories of biology, physics, and chemistry, under teachers so distinguished as Professors Huxley, Guthrie, and Frankland. The Commissioners were, however, informed that the laboratories were over-crowded, and were deficient in the accessories of scientific study, such as may be derived from scientific collections and a scientific library. Moreover, the Royal Commissioners on Scientific Instruction, in their Fourth Report, had expressed their regret that there is at present no national collection of the instruments used in the investigation of mechanical, chemical, or physical laws, although such collections are of great importance to persons interested in the experimental sciences.

"The Commissioners, therefore, concluded that there could be no more appropriate employment of a portion of their resources than to expend them on a building, on their own estate, for the advancement of scientific study and research, and in connection with the existing School of Science. They had, therefore, at the time when they received the deputation, proposed to her Majesty's Government that £100,000 of the amount they might realise in the manner above mentioned should be devoted

to the furtherance of the recommendations of the Royal Commissions on Scientific Instruction by erecting on a site opposite the Government Science Schools, a building suitable for a museum of scientific instruments, or for a library of scientific works, and for laboratories of scientific research and instruction. They had made this offer on condition that the Government would undertake to maintain the building, when erected, in the manner proposed.

"In reference to a passage in the printed statement laid before them by the deputation, the Commissioners think it right to observe that there has been no question among them of the propriety of recognising the claims of the provinces to share in the benefits to be derived from their resources. Their only anxiety has been to discover the form in which such benefit may be best conferred.

"It is said, in the printed statement alluded to, that the special committee of inquiry of the Commissioners had recommended to them 'promoting museums of science and art throughout the country, by grants in aid of buildings or collections of suitable objects,' but on that point the members of the deputation have been misinformed. The special committee referred to the formation of museums by such assistance, but recommended, in lieu of this and alternative plans of applying the Commissioners' funds, the establishment of scholarships for the promotion of science and art as the most advantageous way of assisting the provinces, and the Commissioners concurred in their view. The Commissioners had observed that in recent years a great impulse has been given to the scientific instruction of the population in the great centres of industry by the establishment of provincial colleges of science, and they judged, as their special committee of inquiry reported, that it would be a great benefit to the cause of scientific education if the most promising students in provincial science classes could be enabled to complete their studies, either in those provincial colleges or in the institutions of the metropolis.

"They had, therefore, at the time when they received the deputation, resolved to devote a considerable sum to the establishment of scholarships, to be distributed among the chief centres of manufacturing industry.

"In consequence, however, of the views expressed by the deputation, the Commissioners have, during the present summer, again maturely considered the advantages which, in their belief, would result from the establishment of scholarships, as compared with those which would attend the appropriation of their funds in grants to local museums. The establishment and assistance of local museums is an object which has long commended itself to the Commissioners. In the original scheme, drawn up in the year 1868, for the series of annual international exhibitions, inaugurated by the Commissioners in 1871, it was proposed that 'a sum of money might be annually devoted to make purchases of remarkable objects, which might be sent to local museums throughout the country.' If this scheme had proved permanently successful, they might have been able to supply, by degrees, each of the principal centres of industry with collections of objects illustrating the manufactures of which they are chiefly interested. But, in the present condition of their trust, the Commissioners see several objections to the promotion of local institutions as a method of applying their resources. Firstly, the amount of the funds at their disposal is very limited, as compared with the numerous demands which might legitimately be made upon them in case they announced their readiness to make grants in favour of local institutions. Secondly, the Commissioners fear the risk that the knowledge that a central body was ready with funds to assist local objects would have the effect of decreasing, rather than stimulating, private local subscriptions, and of producing a lukewarmness in local efforts, which would far more than counterbalance the moderate amount of assistance which a share of their funds would provide. Thirdly, and chiefly, it is evident that such grants, while exhausting the Commissioners' funds, would result in mere temporary help to science and art.

"As was remarked by Lord Granville, at the reception of the deputation, museums are, from the lowest point of view, means of showing the working people, the arts connected with their own occupations, and, coupled with educational institutions, they are of the greatest possible value. But, by themselves, museums have only superficial advantages; to be of real use they must be accompanied by educational aids. On the other hand, the Commissioners believe that there is no more efficacious method of applying funds in the advancement of education than the institution of scholarships. It is well known that the offer of very moderate sums in that form produces a great amount of competition even among classes of persons to whom the pecuniary reward is of small importance, and this competition is in itself beneficial both to those who succeed and to those who fail. This plan has also the advantage that, when the Commissioners succeed in letting that portion of their property which they propose to appropriate for building, scholarships can be provided out of the income of the Commissioners, leaving their capital untouched. An objection was made on behalf of the deputation that 'scholarships in connection with local institutions could be only tenable in a very few of the towns represented; only perhaps half-a-dozen have institutions to which scholarships could be affiliated, and thus all the other scholarships would be tenable at institutions in the metropolis.' It is true that the number of towns in which the money awarded as scholarships would actually be spent is small, but the scholarships would be open to the United Kingdom, and would have much wider influence than direct grants made to establish, or assist, local museums; for only a limited number of places can establish art or science museums or schools, whereas every village in the country can send competitors for scholarships.

"For the foregoing reasons, the Commissioners have resolved to adhere to their proposal to apply that portion of their funds which they propose to dedicate specially for the benefit of the provinces in the establishment of scholarships. They have not failed to notice that their proposal met with the approval of the conference held in Birmingham in January, 1877, which resulted in the appointment of the deputation, and that only at the last moment the members of the deputation withdrew their approbation from it.

"The Commissioners have only to add that they will continue to regard with hearty sympathy, and to assist so far as their position allows them, the endeavours of the manufacturing centres of the country to promote those studies in science which are essential to enable England to maintain her high position amid the growing competition of the world, and as long as technical education is as inefficiently provided for in this country as at present the Commissioners think that they ought to keep in their hands the means of meeting the possible requirements of institutions for this purpose.—I have the honour to be, Sir, your obedient servant,

"Henry Y. D. Scott, Major-General, Secretary.

"Joseph Chamberlain, Esq., M.P."

Under the American patents, some 14,000 telephones have, it is stated, during the past year been set up in the United States, and are being rented at an average rental of £10 per annum; and fresh orders are being received at the rate of 1,000 sets per month.

The total exports of petroleum from the United States, in 1877, were 284,012,381 gallons, against 208,912,419 gallons in 1876. New York alone exported 202,344,488 gallons, showing an increase of 86,069,457 gallons. Philadelphia has fallen off nearly fifteen million gallons, whilst Baltimore shows a gain of four millions.

A NEW MINERAL WHITE PIGMENT.*

By Dr. T. L. Phipson, F.C.S.

For many years past attempts have been made by several chemists to discover some new mineral white of a less costly and less dangerous nature than white lead; but very little success seems to have attended these researches until recently. Many years ago, oxide of zinc, produced by the combustion of the metal in the air, was found to have certain properties which allowed it to be used as a substitute for carbonate of lead; but its production is very costly, and its "body" is not comparable with that of the latter. More recently, an ingenious white, or stone-coloured paint, was economically produced from oxide of antimony by Dr. Stenhouse, which appeared to answer very well in certain circumstances. During the last few years I have also made a great number of experiments in the same direction, hoping to utilise some of the artificial silicates which are remarkable for their brilliant white colour. To this effect I have submitted the silicates of zinc, magnesia, and lime, more especially, to a great variety of treatments, but have been, hitherto, unsuccessful in imparting to them anything like the "body" or covering power of lead carbonate. They all become more or less translucid when mixed with oil, and resemble in this respect pure silicic acid, whatever mechanical treatment they may have previously undergone.

Whilst occupied with these experiments, I learnt that Mr. T. Griffiths, of Liverpool, had obtained a new mineral white, the basis of which was sulphide of zinc, and on submitting this new product to a careful examination I found, with astonishment, that it not only surpassed the old zinc white (oxide of zinc), but that it was superior in every respect to carbonate of lead itself. It is obtained by precipitating either chloride or sulphate of zinc by means of a soluble sulphide—sodium, barium, and calcium sulphides have all been used for this purpose—and precautions are taken lest any iron, that may be present in small quantities as an impurity in the zinc solution, should be precipitated with the white sulphide of zinc.

The precipitate being collected and dried is transferred to a furnace, where it is calcined for some time at cherry-red heat, aud carefully stirred so as to bring all parts of it successively in contact with the air. It is then raked out whilst quite hot, into vats of cold water, where it is levigated, and afterwards collected and dried. The result is a white pigment of exquisite beauty; its covering power when mixed with oil is greater than that of any substance hitherto discovered, being about 25 per cent. higher in this respect than that of the same weight of pure carbonate of lead.

According to my analyses of this new product, it consists of au oxy-sulphide of zinc, the composition of which varies somewhat according to the duration of the calcination, and the exact degree of heat obtained. Hence, it is not easy matter to get it precisely of the same composition at each successive operation. Nevertheless, this point is attaiued quite closely enough for all practical purposes. The best product appears to correspond very nearly to the composition: $5\,ZnS + ZnO$. But, occasionally, a somewhat larger proportion of oxide is produced.

Of course a white of this uature is not liable to darken in colour by sulphuretted hydrogen emanations, as occurs with white lead; but it has also the advantage of not proving prejudicial to the health of the workmen who manufacture it or use it.† I have compared it carefully with the old zinc white, and with white lead, as regards covering power, tint, and durability, aud am perfectly surprised at the results of these experiments, which it would be too long to record here; but, knowing as I do from the results of my own endeavours, how difficult it has been to discover a new white of these qualities, I look upon this oxy-sulphide of zinc white as one of the most interesting products hitherto derived from mineral chemistry.

* Read before Section B of the British Association: Dublin meeting.

† It behaves in a perfectly neutral manner towards iron and other metals, which is a quality of the highest importance.

ELECTRIC LIGHTING.

In consequence of the attention aroused by the experimental use in Paris of electricity for street lighting, the Vestry of Chelsea instructed Mr. Stayton, their surveyor, to go to Paris and report on the arrangements used there. Mr. Stayton's report has just been published, and the following is a summary of the principal poiuts therein:—

The Municipality of Paris have contracted with the General Electricity Company to light up certain streets and places, of which the principal are the Avenue de l'Opera and the Place de l'Opera, a street 900 yards long and 30 yards wide. To do this 46 columns have been set up at an average distance of 38 yards apart. Jablochkoff "candles" are used, and Gramme machines. There are three machines, each supplying sixteen lamps, and each driven by a 16-horse power steam-engine, set up for the purpose, so that every lamp takes one-horse power. The conducting wires are laid in the subways below the road. The "candles" last an hour and a half, and cost 7½d. each. The number of candles required for the evening are placed in what is termed a "chandelier," within a ground glass globe, a fresh candle being automatically switched in as the previous one is consumed. Each light is equivalent to 700 wax candles, but the globes take off one-third of this light. The ordinary London street lamp is equal to 12 or 15 candles.

The contract is at present merely an experimental one. The company undertook to light the lamps for a period of six months, ending in November next, from dusk till shortly after midnight, and to provide the whole of the apparatus, for 1f. 45c. (1s. 2½d.) per light per hour. Shortly before the electric light is extinguished, about one-third of the gas lamps are lighted, and continue till sunrise, the former light being unnecessarily powerful, and too expensive to be maintained all night.

The Avenue and Place de l'Opera are usually lighted by the large number of 400 gas lamps, set three or five together on columns, with short intervals between them. Iu spite of the amount of gas burnt, the City engineer says that "the cost of the electric light is four times that of gas, but a greater amount of light is obtained." Ou the other hand, in the lighting of the courtyard of the Louvre, it is asserted that a saving of 29 2-3 per cent. is effected by replacing 201 gas lamps by 16 electric lights, although 3½ times the amount of light is given.

Besides the place above mentioned, the electric light has also been adopted for lighting the Place du Théâtre Française, the Madeleine, the Arc de Triomphe, the Orangerie des Tuilleries, the Magasins du Louvre, and about thirteen other places in Paris. It is also in operation in the principal places in Brussels, Madrid, and St. Petersburg.

Mr. Stayton then proceeds to consider the cost of lighting various parts of Chelsea by means of electricity, as compared with that of gas lighting. To begin with, there is less gas used here than in Paris. The distances between the lamps varies a good deal, for instance it averages 55 yards in Sloane-street, 70 yards in King's-road, 35 yards in Lowndes-square, 35 yards in Cadogan-place, 28 yards on the Chelsea Embankment. In Piccadilly the distance is 30 yards, and in Cromwell-road, South Kensington, 27 yards.

To light Sloane-street, which is 1,100 yards long and 20 yards wide, with two electric stations, each supplying

sixteen lamps, would cost for plant and alterations £3,200, and 16s. per hour for 3,250 hours, or £2,600 per annum. The present cost of a gas lamp in Chelsea burning 3,850 hours per annum is £3 6s. 7d., therefore the expense of the 40 lamps in Sloane-street is 8¼d. per hour, the total per annum for the street being £133 3s. 4d. The outlay for lighting the Chelsea Embankment with 48 lights in place of the 109 gas lamps is estimated at £4,800, and the hourly cost at £1 4s. for 3,250 hours per annum. The present cost of the gas lamps is 2s. 1½d. per hour for 3,850 hours per annum. In Sloane-street the light would be 31 times as great as at present, and it is believed that half the above number of lights would be sufficient. These, however, could not be worked from a single station, so that the chief cost, that of the machines, &c., could not be thus saved.

The main conclusions Mr. Stayton draws are :—That the present arrangements for electric lighting are unsuitable for long distances, especially in London, where the lamps are so much farther than in Paris. The close proximity of the electric stations is a great drawback to the system, and their establishment in business streets would be a matter of considerable difficulty. These are the disadvantages of the system. The following are the advantages:—

About 1½ hours' daily consumption is saved in consequence of instantaneous lighting and extinguishing; the light is vastly superior to gas, and is not injurious; there is an absence of noxious smells both in the production and combustion; the heat in a room, so often unbearable in the case of gas, is scarcely felt; the most delicate colours are preserved; air is not consumed as in the case of gas; there is no chance whatever of explosion; and although the light is so powerful in the streets no accidents to horses have occurred.

On these grounds, he says that after a careful consideration of the whole question, he is of opinion "that at present the electric light is not suitable for street lighting in the metropolis; that it is suitable and can be utilised with splendid effect in large squares and places, such as Trafalgar-square or Parliament-square; but although in each of these places at the present time the lamps are numerous, the cost would be greater than gas." He also makes some remarks on the improvements and modifications required before electric lighting can come widely into use, such as the necessity for further subdivision, and for a means of working over greater distance, points which are of course familiar to those who have paid any attention to the subject.

WEIGHTS AND MEASURES.

The twelfth annual report of the Standard Weights and Measures Department of the Board of Trade has just been published. Mr. Farrer, the Warden of the Standards, has a good deal of variety in the matters which come under his official cognisance. The first part of the report deals with current legislation. In the last Session an Act was passed to consolidate the laws relating to weights and measures, and this consolidation involved also the amendment of certain existing provisions. The new Act provides for the care and restoration of the standards; it "removes doubts as to the legal parts and multiples of the Imperial standards, and provides that no weight or measure is to be used for trade purposes that is not of the denomination of a Board of Trade standard;" it gives certain powers to local authorities to make bye-laws; it alters the procedure in the prosecution of offences; it "recognises the distinction between denominations of weights and measures used or referred to in contracts," &c., "and the material weights and measures used or handled in trade;" it defines the powers of inspectors, &c. A table of equivalents in metric weights and measures of the imperial weights and measures is given. Such in its main features is the Act of 1878, which comes into force on the 1st of January next.

Four kinds of standards are maintained by the Department:—

(*a*.) Imperial standards.

(*b*.) Parliamentary standards or reference copies of the imperial standards.

(*c*.) Board of Trade standards or official copies of the imperial standards.

(*d*.) Local or inspector's standards.

These are all examined from time to time, and certain of them have been examined during the past year. Among them 3,681 inspector's standards were verified, as against 2,103 in the previous year. Without this legal verification, an inspector cannot prosecute for the use of false weights and measures.

Copies of certain of the standards of length have been set up in various places during the year, in London, Dublin, and Manchester, and it is stated that such exhibitions of accurate measures of length have been found to be very useful to engineers, surveyors, tradesmen, and mechanics.

As the new Act renders the weights used for trade purposes by chemists and druggists liable to inspection, standards of apothecaries' measures have been made and verified. Standard measures and weights have been verified free of cost for many scientific persons. Various standards have also been issued to certain of the colonies.

Amongst the matters dealt with by the Department are several points connected with the coinage. It has to maintain the accuracy of the standards used in testing the coins. These, as usual, passed the formal trial of the Pyx satisfactorily. The weights of the Bank and of the Mint were verified during the year. It appears that there are only four towns in the kingdom, viz., Dublin, Manchester, Liverpool, and Lichfield, which have complied with the law in having their bullion standards duly re-verified under the Act of 1853 for regulating the weights used in sales of bullion. The somewhat startling remark is added that "The provisions of the Coinage Act, now included in the Weights and Measures Act, 1878, which require all coin weights to be verified at this office, continue to be generally disregarded."

Some tests are in progress as to the invariability of the standards made of bronze or gun-metal, some recent researches appearing to show progressive molecular disturbances in certain gun-metal compositions which might tend to affect the lengths of any bars constructed of such alloys. The alloy used for the imperial standard this year consists of copper 32, tin 5, zinc 2, this composition having been selected by the Standards Committee of 1841. Subsequent experience has shown that this metal is well adapted for its particular purpose.

The Standard Department now possesses a full set of accurate metric standards, but not "a metre of such accuracy as is required for highly scientific purposes." To obtain this, it is waiting the completion of the verification of a copy of the French standard metre. Among more recent improvements, it is proposed to introduce into this office an instrument for more accurately measuring small end-measures of length, as rifle gauges, by means of electric contract. An improved microscopic apparatus for comparing standards of length is also to be used for scientific purposes.

As work of rather a different character to most of that chronicled in the report, it may be noted that, in compliance with the requirements of section 37 of the Gaslight and Coke Company's Act, 1876, there has been deposited in the office a model of the burner to be used in testing cannel gas supplied by that company.

The survival of a curious ancient tenure is marked by an entry in the report, that "Six ancient horse-shoes and the accompanying 61 hobnails rendered annually to the Crown by the Corporation of London have been transferred to the Queen's Remembrancer's Office," as

all duties relating to the rendering of such services are now directed to be performed at the Office of the Queen's Remembrancer. The origin of this ancient service is given as follows:—"Some persons who held of the King *in capite* by rent-service paid their rent at the Exchequer. Walter le Brun, farmer at the Strand in Middlesex, was to have a piece of ground in the parish of St. Clement to place a forge there, he rendering yearly six horse-shoes for it. This rent was anciently wont to be paid at the Exchequer every year." "It is still rendered at the Exchequer to this day by the Mayor and Citizens of London, to whom in process of time the said piece of ground was granted." These shoes and nails were formerly kept in the Office of the Receipt of Exchequer, an ancient officer of which, the *pesour*, *ponderator*, or *weigher*, had charge of the standard weights of the King.

In the concluding portion of the report, the much vexed question of the Birmingham wire-gauge, the well-known B.W.G., is discussed. It is remarked that there is no standard of such gauge, or common agreement amongst those interested as to what are the dimensions in parts of an inch of the several slots or sizes of the true B.W.G. "Its sizes are not geometrically or arithmetically progressive, and consequently bear no definite relation to each other. Its origin is obscure, and it would appear that the several slots or sizes arose from time to time as a new wire or a new plate was introduced, and as the exigencies of a particular trade demanded. Considerable annoyance to engineers and pecuniary loss to contractors is stated to occur from a want of accuracy in the copies of this gauge, and the necessity of establishing a standard has lately been discussed both in this country and in the United States."

It is, perhaps, no great comfort to be informed that other countries are no better off than ourselves. In Northern Germany the Birmingham wire-gauge, commonly called the "English gauge," is mostly in use for measuring sheet-iron, wire, and hoop-iron. In Southern Germany the B.W.G. is also used, and for the measurement of wires the French gauge, which is a progressive scale of tenths of a millimetre, is also used. For sheet-iron, the "Dillingen gauge" is also used in Southern Germany. The wire factories in Westphalia use a particular gauge called the "Bergish or Westphalian," the sizes of which, like the B.W.G., are established by arbitrary progression. For some time past the question of establishing a uniform wire-guage and a uniform numbering of wires has been agitated in Germany. The manufacturers in Russia use different gauges of English, German, and French patterns. In Canada, only one gauge is known to mechanics—the Birmingham wire-gauge, made by Stubs of Warrington. In France, measurements are made by the scale of one-tenth of a millimetre as well as by the Birmingham and Dillingen arbitrary gauges. In America, the B.W.G. is extensively used. A committee of the American Institute of Mining Engineers recently recommended the adoption of the system of expressing sizes in thousandths of an inch, as in the Whitworth gauge, or in fractions of a millimetre.

It is felt that to introduce any new gauge with sizes progressing arithmetically would only be to add one more element of confusion to those already existing, and the report, therefore, suggests that a standard of the B.W.G. should be constructed, based on the dimensions of the sizes as ascertained by Holtzapffel in 1846. It does not, however, propose that this standard should be legalised, or that in contracts, &c., the sizes of wires and metal plates should be expressed otherwise than in parts of the inch.

Inasmuch as it seems the duty of the Department to weigh everything ponderable and measure all that is capable of measurement, even the air has not escaped its vigilance. The weight of a *litre* measure of dry air without carbonic acid, as calculated for the office, is given as 1·29381 grammes at the temperature of 0°C., and under a pressure of 760 millimetres of mercury.

The weight of a litre of such air has been also calculated to be—

		Grammes.
At Paris	=	1·29320
„ Berlin...............	=	1·29388
„ Vienna	=	1·29348
„ Munich	=	1·29328

Passing again to matters commercial, the report notices that the usual of "loaded" papers for wrapping sugar is falling into disuse, and has been decided to be absolutely unnecessary in just dealings.

The final paragraphs of the report deal with "heaped" and "stricken" measures, the latter being now the only legal measure.

Experiments have been recently made on the different modes of "striking" a measure. The true weight of a standard bushel measure of a certain sort of corn was found to be 57 lb. 2 oz.; the weight of the measure when struck with the ordinary flat strike was found to be 57 lb. 3 oz., and when struck with the ordinary round stick or roller it was found to be 57 lb. 9 oz. "If when struck with the round stick the measure is then shaken the weight becomes 62 lb. 15 oz."

In the measurement of grain the diameter of a measure was found to make but little difference, within certain limits. In measuring such articles as coke, potatoes, &c., the measures most likely to give just results are those whose proportions are such that their diameters are nearly double their depths.

INDUSTRIES OF THE PHILIPPINE ISLANDS.

Consul Palgrave, writing upon the commercial and industrial conditions of the Philippine Islands, states that in pre-European times the trade seems to have been carried on principally, though not exclusively, with China and Japan, the Moluccas on the south-east, and Borneo to the south-west, taking an occasional share. After the Spanish occupation, approximately completed in the latter half of the sixteenth century, the relations between the Philippines and the Celestial Empire were less often friendly than hostile, and trade in that direction was totally interrupted for considerable periods. Henceforth, for two centuries, the principal, indeed almost the only commerce-link between the Philippines and the rest of the world was *via* Acapulco and Mexico. Not until 1764 was trade opened directly with Europe, *via* the Cape, and then even with Spain only, all foreign European flags being at that time absolutely excluded from the Philippine ports, while, as a further restriction, a Spanish Association, called the Royal Company of the Philippines, enjoyed commercial privileges tantamount to a quasi-monopoly of the trade, though not, it would appear, much more to its own advantage than to that of others. Twenty years later European vessels of friendly nationalities were permitted to touch at the port of Manilla, but on condition of bringing thither Asiatic produce only. This state of things continued till, in the first decade of the present century, the door was opened, though very cautiously at the beginning, and under many restrictions, some of which persist down to the actual date, to European traffic in general, first at Manilla only, subsequently at other ports of the island group.

The first English commercial house appears to have been opened in Manilla in 1809, and others, after the pacification of 1815, grew up beside it, though intercourse received an unpleasant check by the massacre of 1819, and Philippine trade continued to be still much fettered by the exclusive privileges of the Royal Company. These, however, finally expired in 1834, since which foreign European trade has gone on steadily increasing. Throughout the Philippines eight ports are

now, under certain conditions, open to foreign flags, the principal of these being Manilla.

Owing to the low condition of skilled industry in the Phillippines, almost every manufactured article of ordinary use has to be imported; on the other hand, the amount of importation, which else would be enormous, is dwarfed, partly by the general want of capital throughout the Archipelago, partly by heavy customs dues, and restrictive regulations or practices in regard of foreign flags. Taken according to value, two-thirds at least of the importation is from Great Britain. The exports are sugar, hemp, tobacco, cigars, coffee, the most important being sugar. This is of two kinds, clayed, or dry, and unclayed, or moist. The sugar cane is extensively cultivated in the central provinces of the island of Luzon, and in the large island group of Panay, Negros, and Cebu, on the south-west of the Archipelago. In the last-named localities, the violet-coloured cane is most common; in Luzon, the white. The larger estates, some of which exceed 1,000 acres, are mostly in the hands of "Mestizos," or natives of mixed European, Chinese, and Malay descent. Many Europeans have at various times acquired and managed estates, but their success has not equalled that of the "Mestizos." A great number of estates, but generally small ones, varying from 20 up to 300 or 400 acres in dimensions, belong to Malays. The average yield, so far as can be ascertained, of the cane as cultivated at present is about three-fourths of a ton of sugar per acre. But the mills are in fault; many are wooden; some iron, but worked only with buffalo-power; two only have a complete system of clarifying-pans and centrifugals; none a vacuum pan. With machinery, &c., like that of Demerara or Martinique, the same cane could not fail to yield over two tons of sugar per acre. Nowhere is manure employed. Of the 2,669,570 acres which, according to a survey made in 1873, were under cultivation in the island of Luzon, 340,277 were in cane. The extent occupied by the same growth in the islands of Panay, Cebu, and Negros, especially the last, is probably much greater. The smaller estates are cultivated by the proprietors themselves, assited by their families, relatives, and less frequently by hired or bond labourers, for the Malay system of bond-service, differing little in practice from temporary slavery, still exists, though legally prohibited, in many agricultural districts. On the larger estates the "mezzanero" system, or part share, is common; it is a partnership of profits in which the farmer usually gets the lion's share, especially if the proprietor be a European. The sugar made is coarse in quality; nor is rum distilled in any large quantity from the molasses, the Malays liking the palm wine better.

The culture of the abaca, from which the Manila hemp is made, is simple enough. Shoots are preferred to seedlings; they are planted out at a distance varying from six to ten feet apart, and the ground between is, or ought to be, kept clear of weeds. In a period averaging three years they are fit for cutting. After flowering, a process which it is seldom allowed to complete, the plant is useless for fibre. The fibre is prepared by hand-labour; no European-made machine having as yet, in spite of many endeavours, succeeded in superseding the rough contrivances used by the natives, their inventors. It is dried in the sun, and then carted off by buffaloes to the press stores, where it awaits embarkment. The abaca plant is indigenous to the Philippines, and has been cultivated by the Malays for the sake of its fibre, out of which they still continue to weave a considerable portion of their wearing apparel, as they have done from time immemorial. But it is only within the last twenty years that it has risen into importance. The plantations are, individually taken, small; each the property of some Malay family. The number of acres occupied by it in Luzon, in the year 1873, is stated at 23,682; that in Samar, Leyte, and the others, may be ten times as much. Its cultivation has, however, for the last three or four years, been nearly stationary. As the sugar-cane districts are, in the general condition of their inhabitants, the richest and best off, so the abaca districts are, of all cultivated spots, the poorest and worst off in the same respect of the Philippines.

The coffee plant, of the same variety as that cultivated in Brazil, was introduced into the Philippines in the latter part of the eighteenth century; but for many years little attention was paid to it. About forty years ago it was for the first time cultivated on a respectable scale, in an estate not far from the capital; and it is at present widely disseminated through the provinces of west-central Luzon, namely, Cavité, Laguna, and Batangas. It is also cultivated in the southern island of Mindanao. Its cultivation as practised is of the rudest kind, and Consul Palgrave believes that no product could easily be made more abundant and more lucrative throughout the Philippine group, were proper agricultural care taken, than coffee. The tobacco, as is well known, forms in these islands a Government monopoly of a kind at once the strictest and the most comprehensive; in some districts its cultivation is compulsory, in others optional, but in every case the sale and distribution are absolutely in the hands of the Government. The number of acres occupied by tobacco in 1873 was 60,432; they are almost all situated in the northern half of Luzon; they have certainly not increased since that date. A comparatively small amount of land is also planted with tobacco in the Visayas central island group.

The minor products are sapan-wood, buffalo hides, mother-of-pearl shell, gum mastic (copal), indigo, tortoise-shell, cocoa-nuts, and cocoa-nut oil; fancy work in pine-apple fibre and a few other trifles are also exported, but their quantity is small, and their worth inconsiderable.

CORRESPONDENCE.

OPEN-MOUTHED PIPES *VERSUS* VENTILATORS.

I quite agree with the very sensible suggestion which was made in the last number of the *Builder*, by Mr. T. Blashill, under the above heading. I have no doubt he sees the difficulties which would attend a complete, a satisfactory inquiry, and has not thought it necessary to state more fully the conditions. I venture to think that, if his suggestion can be properly carried out, it will prove of greater value to the public than Horse Shows, Dog Shows, Fan Shows, and the like. It will also doubtless prove of great pecuniary advantage to the makers of such ventilators as shall be found to be the best for all the practical purposes of proper ventilation. The conditions will require, of course, to be carefully settled with that object solely in view, and gentlemen who have already acted as judges in late cowl-tests would probably consider themselves ineligible as judges in the suggested inquiry, which I should submit had best be undertaken by the Society of Arts, the Institute of Civil Engineers, or the Institute of Architects, or a committee formed of members of all three.

Playing at cowl-testing would have no useful result. Ventilation is, perhaps, as little understood as any science. It is a very important branch, and there can be no doubt the committee would be undertaking a most difficult and arduous task, and one in fact, which would scarcely be worth while unless the tests extended over a period long enough to include all winds and all weathers, ever varying velocities of winds, different states of the atmosphere, within and without, permanence of "pull" when there is not a natural up current, and freedom from down draught when there is a natural down current, exclusion of water in wet

weather, and through condensation, serious failings in plain open or trumpet-mouthed pipes, even if they be capped or be made lobster-backed, and which alone may, upon consideration, be thought sufficient to exclude them from the comparative tests, besides which they freely—often too freely—admit cold air down them, although at other times they allow of the escape of vitiated air up them. Considering the various and great changes which so often and so suddenly occur in some of the most important conditions, it may be considered necessary to test the various ventilators more continuously at the same time against each other, and in such case two tubes will, perhaps, not be enough. I feel certain such an inquiry cannot be properly carried out without considerable expense, towards which exhibitors should mainly contribute.

Exhibitors of ventilators, cowls, and pipes, should be divided into at least two classes, those who do not intend to enter any of their exhibits as competitors for supremacy, and those who do. The judges or committee should have power to exclude from the contest any ventilator, cowl, or pipe, which they may deem ineligible from whatever cause. Each competitor for supremacy should pay an entrance fee (in proof of his own good opinion) of, say, one hundred guineas, and those who intend to exhibit only, should pay a fee of, say, ten guineas. The fund, after payment of expenses incurred, to be applied as the committee may direct.

I shall be glad to pay one hundred guineas for the privilege as mentioned, and no doubt others who have equal confidence in their ventilators will be glad to do so also.

E. Gregson Banner.

11th September, 1878.

NOTES ON BOOKS.

The World on Wheels.—By Ezra M. Stratton. New York, Author, 1878.

This is an historical sketch of the coachbuilder's art and its results from the time of Rameses the Great (circa 1500 B.C.) down to the American Exhibition in 1876. The first picture is the primitive sledge, of no particular date, and the last is a hearse which took a prize at Philadelphia. Between these two extremes come 400 illustrations of carriages of every shape and size, and every period. The chariots of the Assyrian sculptures, of Egypt, Pompeii, Rome, and Greece, with many others, are all figured and described at length, while, in the latter part of the book, full accounts are given of the carriages used in all modern nations. In any future edition, perhaps Mr. Stratton may find some information worth quoting as to the origin of the London Hansom in an article which appeared in this *Journal* in 1873.*

GENERAL NOTES.

The Megaphone.—Mr. Edison writes to Messrs. Horne and Thornwaite as follows:—"The newspapers have grossly exaggerated matters in regard to the megaphone. It is true I have been experimenting upon an apparatus for the benefit of those partially deaf, and with a fair degree of success, but should my efforts prove successful it will be several months before the instrument will be placed in the market."

* *Journal* for March 28th, 1873.

The Ronalds Catalogue.—In one of the General Notes in last week's *Journal*, it was stated that the Ronalds Catalogue of Books and Papers on Electricity and Magnetism was about to be published by the Society of Engineers. This, of course, was a misprint for the Society of Telegraph Engineers, to which body the Ronalds library was presented by Mr. S. Carter, the brother-in-law and legatee of Sir Francis Ronalds. The gift was accompanied by certain conditions, one of which was that the society should bear the expense of printing and publishing the catalogue, upon the compilation of which Sir Francis Ronalds spent the greater part of his life.

"Vulcanised Fibre."—The *British Trade Journal* gives the following account of a new material, under the name of "Vulcanised Fibre." An American firm, whose works are at Wilmington, are producing a material whose basis is paper, and which admits of a variety of useful applications. It is prepared from a thick, spongy reddish-brown paper, specially made for the purpose, which, being acted upon by certain chemicals, loses its original character and is tranformed into a homogeneous substance of almost metallic hardness. The material emerges from the process of manufacture in large flat sheets, which are made up into a long list of articles. The Vulcanised Fibre Company's largest orders, however, are for railway supplies, including fish-bolt washers, oil-box covers, "dust guards," for axles of cars, &c. The company, it is stated, sell nearly a quarter of a million track-bolt washers per month. One place in which the material has supplied an important want is in the condense-pipes of ocean steamers, where it is exposed without resulting injury to the action of salt water and to the constant strain produced by the alternate contraction and expansion of the pipes. From the scraps left in tho cutting of larger articles immense quantities of carriage washers are made. "Roving cans," a tall cylindrical vessel used in cotton-mills, and formerly made of tin, are now made of this material, which is dealt with much as if it were wood, being sawn, or cut, or turned. Unfortunately it does not admit of moulding, which would obviate the great waste necessary in cutting out small articles from large sheets. A perforated chair-seat made from vulcanised fibre is said to be as cheap as the wooden one, and more elastic and durable. As yet it has not been largely applied to making ornamental articles; but its beauty of finish makes it particularly suitable for such purposes. Napkin rings are made of it, as hard as bone, and as tough as leather. When made up into these articles the material is transformed beyond recognition; for it is, like the somewhat analogous substance, celluloid—also a paper product—capable of receiving various colours, and is used both in the polished and unpolished state. A cylinder of it when black looks like sheet-iron, and when the black fibre is made into solid rectangular blocks it is almost impossible to tell it from ebony. A walking-stick of vulcanised fibre might be taken for any one of a half-dozen materials.

Elephants for African Travel.—The *Academy* notes that a successful experiment has lately been tried in the equatorial provinces of Egypt, which may not improbably ere long revolutionise the mode of transit in Eastern Africa, and solve a problem which has hitherto puzzled travellers. About a year ago, at Colonel Gordon's request, a few trained elephants were sent to Khartum, were they arrived in due course, having marched along the banks of the Nile. A report has been received in Cairo from Colonel Gordon stating that he had despatched them to the military station of Lardo, about 11 deg. south of Khartum, and six miles north of Gondokoro, and that they had accomplished this distance in 84 days. A not unimportant advantage to be derived from the employment of elephants in this manner was demonstrated by the fact that the negroes along the line of march were frightened by them, and made no attempt to attack the party. The elephants have gradually learned to live on leaves and grass, as the wild elephants do, and keep in first-rate condition without the different kinds of food to which they had previously been accustomed. Colonel Gordon consequently advises travellers going into the interior of Africa from Zanzibar to use elephants, and thus to avoid the necessity for a host of porters, who are a never-ending source of delay and annoyance. It may be remembered that the question of employing elephants in African exploration was discussed after the reading of Mr. H. B. Cotterill's paper on the Nyassa, for the Society's African Section on the 28th of May last.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,348. Vol. XXVI.

FRIDAY, SEPTEMBER 20, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

PROGRAMME OF EXAMINATIONS FOR 1879.

The Programme for 1879 is ready, and can be had on application to the Secretary. The Society's Examinations now comprise the following divisions.

1. Commercial Knowledge.
2. Domestic Economy.
3. Fine Arts applied to Industry.
4. Music.
5. Technology of Arts and Manufactures.
6. Elementary.

A Pamphlet containing Specimen Examination Papers in most of the subjects is published, and may be inspected by intending Candidates in the Libraries of the Institutions in Union with the Society; or copies may be had on application to the Secretary of the Society of Arts, price 6d.

NATIONAL WATER SUPPLY.

HEALTH AND SEWAGE OF TOWNS.

The Reports of the Congresses on the above subjects have been published in pamphlet form, and each report can be obtained at the Society's House, price 2s.

SOCIETY OF ARTS' MUSICAL SCHOLARSHIPS.

Notice is hereby given, that a competitive examination will shortly be held for one of the Society's Scholarships, now vacant, at the National Training School for Music.

The following are the rules for the admission of Candidates to compete:—

1. A competition for one Scholarship will take place during the present month (September, 1878).
2. Candidates to compete must be nominated by a Member of the Society of Arts, each Member having the privilege of nominating a Candidate.
3. The nomination must be made on the form, and in the terms given below. Copies of the form for this purpose will be supplied to Members on application to the Secretary of the Society of Arts. The Candidate's age must not exceed 20 years. A violinist will be preferred.
4. The examination of the competing Candidates will take place at the Training School. The date, when fixed, will be notified to each Candidate properly nominated.
5. The subjects in which the Candidates will be examined in the competition are as follows:—

a. Reading aloud and recitation with clearness of pronunciation; writing legibly from dictation.
b. Elementary knowledge of musical notation and knowledge of the principles of music.
c. Performance on some instrument or singing (at sight also if possible) or composition.

6. The attention of Members is specially drawn to the foregoing requirements, and it is particularly requested that they will exercise great care to nominate those only who they feel assured can fairly fulfil them.
7. Members nominating must send in to the Society of Arts with each nomination form—

a. A certificate from some one of recognised musical position, showing that the Candidate is qualified to compete.
b. A medical certificate showing that the Candidate is in good health, and has no defect which would impede the practice of vocal or instrumental music.
c. The copy of a register of birth.
d. The certificate of two well-known persons in a locality that he, or she, is of good moral character.

8. Previous to the competition an examination fee of 5s. must be paid by the competitor to the Society of Arts.
9. ADMISSION TO THE SCHOOL AFTER COMPETITION.—After a Candidate has been successful in a competition, and has been named for a Scholarship, he or she will be admitted to the Training School upon the production of the above-mentioned necessary certificates of health, birth, and character; and his or her continuance as a Student in the Training School will depend on the report of progress by the Examiners and the Director of Studies.

NOTE.—*On admission the Student will be required to furnish the statement from the Society of Arts Examiner as to his or her capacity, previous musical studies, and antecedents.*

10. The Scholarship confers the right of obtaining the best musical instruction in the School without payments of any kind, either as fees, or for instruments, music, or books, which are provided for use in the School. The School does not provide board or lodging.
11. The nomination paper for the competition, duly filled in and signed by the Member nominating, accompanied with the necessary certificates, and the Candidate's fee, must be sent in at once to the Secretary of the Society of Arts, John-street, Adelphi, London, W.C.

(By Order),
P. LE NEVE FOSTER, Secretary.

September, 1878.

The following is the form of nomination:—

SOCIETY FOR THE ENCOURAGEMENT OF ARTS, MANUFACTURES, AND COMMERCE,

JOHN-STREET, ADELPHI, LONDON, W.C.

NATIONAL TRAINING SCHOOL FOR MUSIC.

I, the undersigned Member of the Society of Arts, hereby nominate

Name ....
Age ....
Address ....

as a Candidate qualified to compete for a Scholarship.

Member's signature ....
Address ....
Date ....

MISCELLANEOUS.

THE CO-EFFICIENT OF FRICTION FROM EXPERIMENTS ON RAILWAY BRAKES.*

By Captain Douglas Calton, C.B., F.R.S., D.C.L.

The author of this paper has been recently engaged in making some experiments upon the co-efficient of friction when the surfaces in contact move at high velocities, in connexion with the action of brakes in use on railways; and the results which have been arrived at appear to present some interesting features in respect of the laws which govern the co-efficient of friction.

These experiments form the first instalment of a series which it is intended to make, to ascertain, 1st, the actual pressure which it is necessary to exert on the wheels of a train to produce a maximum retardation at different velocities; 2nd, the actual pressure exerted on the wheels in the several forms of continuous brakes now in use; 3rd, the time required to bring the brake-blocks into operation in different parts of a train in the several forms of continuous brakes; 4th, the retarding power of the different kinds of continuous brakes now in use on trains under similar conditions of equal weight and running at the same speed.

This paper includes the first series of experiments only.

The author was enabled to make this series through the courtesy of the London, Brighton, and South Coast Railway Company, and of their locomotive superintendent, Mr. Stroudley, who provided a van and other facilities for making the experiments; and through the courtesy and assistance of Mr. Westinghouse, by whom the recording apparatus was designed. The author was assisted in making the experiments, and in their reduction, by Mr. Horace Darwin.

The experiments were made on the Brighton Railway, with a special van constructed for the purpose; it was attached to an engine, and was run at various speeds, during which time various forces were measured by self-recording dynamometers. These dynamometers were designed by Mr. Westinghouse; their principle is that the force to be measured acts on a piston fitting in a cylinder full of water, and the pressure of the water is measured by a Richards' indicator, connected by a pipe to the cylinder; thus, as the drum revolves, diagrams are obtained, giving the force acting on the piston. The advantages of this method are obvious, as the indicator can be placed at any convenient point, and the inertia of the water tends to make the pencil keep a position corresponding to the mean force.

The piston, and what answers to the cylinder, would be better described as a ring fastened to the edge of a cylindrical box. The rod by which the thrust is to be measured is transmitted to the piston. This piston merely consists of a cast-iron disc, with a cavity in its centre, in which the rounded end of the rod rests, and a projecting piece at its centre on the other side acts as a guide. The ring, which takes the place of the cylinder, is of the same thickness as the piston, and in its centre the piston fits. This ring is screwed to the edge of a cylindrical box, to which the ring with the piston thus forms a cover. The piston fits so as to slide easily, with but little friction, and is made water-tight by placing a disc of india-rubber under it, which is fastened to the centre of the piston by a brass collar, and has its edges clamped in between the ring and the edge of the cylindrical box. Thus we have a perfectly water-tight piston, which will move with very little friction, and as its movement is very small, the disturbing effect of the india-rubber at its edge may be neglected; thus the indicator will register the forces acting on the piston by means of the pressure of the water. The pipe leading to the indicator is screwed into the socket. We will neglect the valve for the present, and explain its use a little further on. Suppose the whole apparatus to be filled with water, and that a force were applied to the piston by the rod, it would force some of the water out of the vessel through the opening into the indicator cylinder; the area of the indicator piston is half a square inch, and its maximum range ·8 of an inch, therefore the quantity of water required to make a maximum movement of the pencil is 0·4 cubic inches, and as the area of the piston is 30 square inches, its movement would only be 0·013, or $\frac{1}{75}$ in., which is such a small movement that the india-rubber will introduce no appreciable error. Now, if the indicator piston did not leak, and if it were possible to keep exactly the right quantity of water in the apparatus, nothing more would be required to make it work properly, but as this is evidently impossible, the supply valve becomes necessary. A small pipe, leading from an accumulator loaded to a greater pressure than can ever arise in the vessel, is screwed into the socket; the excess of pressure on the outer side tends to close the valve; there is also a spring which forces the valve on to its seat. This valve is seated with india-rubber, and is made perfectly water-tight. The spindle passes up so as very nearly to touch the brass collar on the underside of the piston. Suppose the whole apparatus to be filled with water when there is no force acting on the piston; then if a force is applied, this will move the piston downwards, so as to send some water into the indicator, and raise the pencil, and will also open the valve, and, as the pressure in the accumulator is in excess of that in the vessel, the water will enter, and go on entering till the piston is raised and no longer opens the valve. Now, if the force on the piston be removed, the indicator spring will force a quantity of water less than 0·4 cubic inches back into the vessel and raise the piston less than $\frac{1}{75}$ in., and thus the piston can only move $\frac{1}{75}$ in. above the position in which it touched the valve. Again, if we suppose a smaller force to be applied to the piston, it will not be pressed down so far, and will not open the valve, unless sufficient leakage has meantime taken place to allow the piston to come down through its full distance; thus the valve always keeps the right quantity of water in the apparatus to make it work properly, by occasionally opening and letting in enough water to make up for leakage.

A special brake van was built by the London, Brighton, and South Coast Railway Company for these experiments, to which the Westinghouse automatic brake was applied, with four dynamometers like the one described, attached to it. Nos. 1 and 2 measured the retarding force which the friction of the brake-blocks exert on the wheels; No. 3, the force with which the blocks press against the wheels; No. 4, the force required to drag the van. The arrangement of the levers for applying the brake is not the same as that used on the ordinary rolling stock of the Brighton Railway, but has been slightly modified by Mr. Westinghouse, in order to make the pressure equal on both sides of the wheels, and to provide for the application of the dynamometers. Into the cylinder belonging to the Westinghouse brake apparatus the compressed air flows from the reservoir when the brake is applied, and forces the two pistons apart, thus moving the two rods outwards, and by means of their levers, pressing the brake blocks against the wheels. It is evident that the pressure must be equal on each side of the wheels, and that the pressure on the dynamometer No. 3 must be equal to the thrust on the rod, and hence proportional to the pressure on the wheels. The lever pivoted at its centre will evidently tend to turn with a moment equal to the retarding moment exerted by the friction of the

* Read before Section G of the British Association; Dublin meeting.

brake-blocks on the wheels; and hence the dynamometers Nos. 1 and 2 will register forces proportional to this moment. The brake could be applied to all the wheels of the van, but during the experiments it was only applied to the pair of wheels to the levers of which the dynamometers were attached. Dynamometer No. 4 is connected to the draw bar by a lever, and thus registers the force required to draw the van.

A self-recording speed indicator was used, designed by Mr. Westinghouse. This instrument has been repeatedly tested, and was used at the brake trials on the North British Railway, and on the German State Railway. It consists of a small dynamometer made on the same principle as that just described; it measures the centrifugal force of two weights, which are made to revolve by a strap from a pulley on a shaft driven by friction gear from the pair of wheels to which the brake was applied; a Richards' indicator being used, as in the other dynamometers. Thus, as the centrifugal force varies as the square of the velocity, the speed is got by taking the square root of the ordinates at any point. There is also a Bourdon gauge attached to the above small dynamometer, with the face divided in such a way that the hand shows the speed in miles per hour.

These diagrams thus show the speed of the pair of wheels to which the brake was applied, and therefore the velocity of the train at the moment of applying the brake and subsequently (provided there is no slipping). Any variation in the speed diagram is due to the wheels slipping, and shows to what extent and in what way the brake stops the wheel.

Two of Mr. Strondley's indicators were fixed side by side in the van; one attached to the axle belonging to the braked wheels, the other to the axle which was running free. The difference of these indicators showed if slipping took place.

Speed indicators were also attached to the van; but these do not register automatically.

The distribution of the weight of the van between the two pairs of wheels was obtained, as well as the weight of the wheels and axles themselves.

In order to ascertain the weight thrown on the braked wheels during the progress of the experiment, a dynamometer fitted to the springs of the van showed the weight at every moment carried on the unbraked wheels, from which information it was easy to deduce the weight on the braked wheels.

The indicators are all placed on a table in the centre of the van, and the drums are made to revolve by the cords being wound up on pulleys on the shaft. This shaft is turned at a uniform rate by a water-clock. This clock merely consists of a plunger sliding in a cylinder through a water-tight packing, and loaded with a heavy weight; it is wound up by connecting it with the accumulator, and at the beginning of each experiment a small cock is opened, which allows the water to run out and the weight to fall, which thus turns the indicator down, and at an ascertained uniform speed. Thus the ordinates of the diagrams taken from these indicators show the various forces, and the abscissæ the distance moved through by the van.

In these experiments the tyres were of steel, and the brake-blocks of cast iron.

The apparatus was designed by Mr. Westinghouse, and constructed under his supervision by the Brighton Railway Company, through whose assistance these experiments were carried into effect.

The effect of applying the brake to the wheels is two-fold. So long as the wheels to which brakes are applied continue to revolve at the rate of rotation due to the forward movement of the train, the effect of the blocks is to create retardation by the friction between the block and the wheel; but when the pressure applied to the block causes the friction to exceed the adhesion between the wheels and rail, the rotation of the wheels is arrested, and the wheel becomes fixed and slides on the rail, being held in its fixed position by the brake-blocks.

Therefore the experiments give the co-efficient of friction:—

1. Between the brake-blocks and the wheel, which is equal to $\dfrac{\text{the tangential force}}{\text{the pressure applied.}}$

2. Between the wheel and the rail, which is the $\dfrac{\text{friction of the brake-blocks}}{\text{weight upon the wheels}}$

They moreover afford a measure of the adhesion between the wheel and the rail.

It has been generally stated that there is no difference in the co-efficient of friction observed in the case of bodies at rest, *i.e.*, in a condition of static friction, and the co-efficient of friction in the case of moving bodies, *i.e.*, in a condition of kinetic friction; but Mr. Fleeming Jenkin, in his paper read before the Royal Society, in April, 1877, upon the friction between surfaces moving at very low speeds, alludes to the fact that in cases where a difference in the co-efficient of friction is observed between static and kinetic friction, the static friction exceeds the kinetic.

Average.		Co-efficient of Friction between Cast-Iron Brake Blocks and Steel Tyres of Wheels.			
Miles per Hour.	Feet per Second.	At Commencement of Experiment, *e.g.*, to Three Seconds.	At from 5 to 7 Seconds.	At 12 to 16 Seconds.	At 24 to 25 Seconds.
60	88	·062	·054	·048	·043
55	..	..	..	..	..
50	73	·100	·070	·056	..
45	65	·125	..	..	..
40	58	·134	·100	·080	..
30	43	·184	·111	·098	..
20	29	·205	·175	·128	·070
10	14	·320	·209	..	..
Under 5	7	·360	..	..	..
Fleeming Jenkin—Steel on steel dry	·0002 to ·0086	·351 mean ·365 max.	..	..	..
Morin—Iron on iron	..	·44	..	...	..
Rennie—At pressure of 1·6 cwt. per square inch wrought iron on cast-iron..	..	·275	..	..	..
,, —Steel on cast-iron......	..	·400	..	..	..

Coulomb also points out in his experiments that in the ease of static friction the co-efficient of friction increased with the time during which the bodies had been at rest.

The experiments of Coulomb, Rennie, Morin, and Jenkin, were made with bodies moving at comparitively low velocities.

The Table (p. 905) shows the mean results obtained from a large number of the experiments made with the apparatus above described, upon the action between the east-iron brake-blocks and the wheels fitted with steel tyres.

A limited number of experiments were made with wrought iron blocks upon the steel tyre, a mean of which gave the following result:—

Average.		Co-efficient of Friction between Wrought Iron Blocks on Wheels.			
Miles per Hour.	Feet per Second.	At Commencement of Experiment to 3 Seconds.	At from 5 to 7 Seconds.	At 12 to 16 Seconds.	At 24 to 25 Seconds.
48	..	·110	..	..	..
31	..	·129	·11	·099	..
18	..	·170	..	..	..

The following Table shows the result obtained by the sliding of the wheel on the rail, that is, a steel tyre and steel rails:—

Average.		Co-efficient of Friction between Wheel on Rail, Steel on Steel.			
Miles per Hour.	Feet per Second.	At Commencement of Experiment to 3 Seconds.	At from 5 to 7 Seconds.	At 12 to 16 Seconds.	At 24 to 25 Seconds.
50	..	·04	..	..	..
45	..	·051	..	..	..
38	..	·57	·044	·044	..
25	..	·080	·074	..	..
15	..	·087	..	..	..
10	..	·110	..	..	..

The general results of these Tables show that the co-efficient of friction between moving surfaces varies inversely in a ratio dependent upon the velocity at which the surfaces are moving past each other; probably the equation would be of the form of $\frac{a}{b+v}$.

The eo-efficient of friction, moreover, at these velocities becomes smaller also after the bodies have been in contact for a short time. That is to say, the longer the time the surfaces are in contact, the smaller apparently does the co-efficient of friction become. This result appears more marked in the case of cast-iron blocks than of the wheel sliding on the rail, at all events for the first thirty seconds of the contact, the arrangement not admitting of the experiments being carried on for a longer time. This effect, however, does not appear to be unnatural, as the friction developes heat, and the consequent expansion tends to close up the pores, and to make the heated surface a more united surface than the colder surface. Besides which, it is probable that in the act of rubbing, small patehes may be detached, which may act as rollers between the surfaees.

It will also be observed that the co-efficient of friction between the east-iron block and the steel tyre is much larger than that between the steel tyre of the wheel and the rails, which were also generally of steel.

As has been above mentioned, the sliding of the wheel on the rail takes place when the frietion of the brake-blocks is greater than the adhesion between the wheel and the rail, which is due to the weight upon the wheel. This was found to amount generally to about 24 to 28 per cent. of the weight.

The influence which these results have upon brakes for railway trains may be briefly summarised as follows:—

1. The application of brakes to the wheels, when skidding is not produced, does not appear to retard the rapidity of rotation of the wheels.

2. When the rotation of the wheels falls below that due to the speed at which the train is moving, skidding appears to follow immediately.

3. The resistance which results from the application of brakes without skidding is greater than that caused by skidded wheels.

4. The pressure required to skid the wheels is much higher than that required to hold them skidded; and appears to bear a relation to the weight on the wheels themselves, as well as to their adhesion and velocity.

In order to produce a given result at different velocities, the pressure applied to the brake-blocks must vary in the proportion shown by the co-efficient of friction.

Thus at 50 miles an hour the pressure required to make one pair of wheels slide on the rail was nearly 27,000 lbs., whilst at 20 miles an hour a pressure of about 10,300 lbs. was found sufficient to obtain the same result.

The strain on the draw-bar showed that the retarding force or the tangential strain between the brake-blocks and the wheels followed very nearly the same law of variation. This is to say, in order to produce a degree of friction on the wheel at 50 miles an hour which shall exert a retarding force on the train equal to that at 20 miles an hour, the pressure applied to the brake-blocks at 50 miles an hour must be nearly two and a half times as great as that required at 20 miles an hour, and a still greater pressure is required for higher velocities.

Therefore, whilst a comparatively low pressure would make the wheels slide at low velocities, it was difficult to obtain any sufficient pressure to make the wheel slide at velocities over 60 miles an hour.

The figures given in the above tables must at present be accepted as only provisional, until an accurate mean has been obtained from the diagrams, which are not yet all worked out. But it may be assumed as an axiom that for high velocities a brake is of comparatively small value unless it can bring to bear a high pressure upon the surface of the tyre almost instantaneously, and it should be so constructed that the pressure ean be reduced in proportion as the speed of the train is reduced, so as to avoid the sliding of the wheels on the rails.

Trade Marks notes that, with the 30th June, the German Patent-office concluded the first year of its existence. During that period the total of applications for patents was 18,867 (half-year, 1877, 7,169; first quarter, 1878, 5,134; second quarter, 6 564). The number of applications for patents was in the first business year 6,336. Of these, 4,016 were, on the 30th of June, admitted to publication; the rest are still being dealt with.

The Government of South Australia are offering a bonus of £4,000, in pursuance of a Parliamentary vote, to the inventor of the best machine combining the operations of reaping and cleaning wheat, &c., fit for bagging in the field.

ELEPHANTS FOR AFRICAN TRAVEL.

Sir Samuel Baker has recently received from Khartoum the following account of a novel experiment in African travel:—

"The most interesting piece of news since I last wrote to you is the safe arrival of six elephants at Dufli. Some years ago the Khedive had been made a present of five elephants from India, and as they were nearly eating their heads off in idleness at Cairo, Colonel Gordon suggested having them taken up to the equator, together with one smaller African elephant from the Gizereh Gardens. They went in charge of some Indians up to Assuan, where Mr. Rosset took them on to Khartoum, *viâ* Halfa Dongola and the Bayuda desert. At Mudurman they swam across the White Nile, and have there been employed for some months in amusing the people of Khartoum. When Colonel Gordon was here last time he commissioned Mr. Marco, a Dalmatian, who had already proved himself a very active and useful man at the Sobat, where he was stationed for sometime, to take them to Lado. Mr. Marco returned here a few days ago and gave a very interesting description of his expedition. He left Khartoum with a few Indians and some Negro soldiers, who had already been trained here to attend to the elephants, in the middle of February. The expedition went along the eastern banks of the White Nile until they came opposite Hellet Kaka, where they swam across the river without more trouble than it would take to row a boat across, the men being on top of the elephants. From Hellet Kaka they went on to Fashoda, where they remained for 27 days, as the Indians had had enough of the White Nile. When the Negro soldiers had received their finishing touches in attending to their charges, the expedition went along the western banks through the Shillook country until they were opposite the Sobat. There they swam the river once more, landing a little to the south of the junction of the Sobat with the White Nile.

"Now the great march across the country from the Sobat to Bahr commenced, a piece of ground not yet traversed by anybody, Arab or European. It took them 81 days to reach Bahr, and they suffered much on this route. They only took provisions for 20 days, depending on the natives on the way. This was, however, a mistake, as the people all ran away when they saw men riding on elephants, believing, I suppose, the devil himself had appeared in their country. They swam many chors and lakes, and reached at last Bahr, where they got fresh supplies. From Bahr to Lado they took 10 days more, where they remained on the eastern banks. They went after some time to Dufli, where the elephants are now employed in carrying all kinds of heavy goods.

"The whole affair is really, besides very interesting, also very important, and ought to find due appreciation in African geographical circles; and pray make any use of this letter you think proper. Three points are certain now—the Indian elephant can live in Africa; it need not be fed in the luxurious manner that is thought indispensable in India; and Indian attendants are not required.

"The chief obstacle to African explorers is procuring porters; but who would require these if he had 15 or 20 elephants? I may be a little too enthusiastic about the matter; but, from all I hear from Mr. Marco, I really think Africa might have been explored a hundred years ago with the aid of Indian elephants. At least, one can go so far as to say that, in expeditions where money is not so much the object—for instance, expeditions like Lucas's, Stanley's, &c.—elephants ought in future to be employed."

It may be remembered that the question of employing elephants in African exploration was discussed after the reading of Mr. H. B. Cotterill's paper on the Nyassa, before the Society's African Section, on the 23th of May last.

THE CARAVAN ROUTES.

The earliest trade between the East and the West was carried on by caravans, and long after the sea routes by the Red Sea and Persian Gulf began to be used, the land trade continued to be more important than the sea-borne. The earliest of these caravan routes were those between Egypt, Arabia, and Assyria, and the first notices we have of them are in the Bible. Dr. Birdwood, in his handbook upon the Indian exhibits at the Paris Exhibition, mentions the existence of an immemorial commerce between India and the nations of the Mediterranean, and of the three principal routes it, in different ages, followed; that by Kirman, Gerrha, and Petra, probably the oldest of all. There was no other route between India and Europe where so small a space of sea had to be traversed, and the coast of Arabia is visible over the Straits of Ormuz from Kirman. The produce of India came to Kirman *viâ* Ormuz, and was thence carried across the Persian Gulf to Gerrha, the emporium of the pearl fishery still carried on among the Bahrein Islands, the ancient Tylos and Aradus, which, with Muscat, were the original seats of those seafaring Arabs, who afterwards established themselves in Phœnicia, and carried their settlements from port to port along the eastern and southern shores of the Mediterranean, from Tyre and Sidon to the coasts of Mauritania.

The Indian caravan routes extended across the peninsula from Masalia, now Masulipatam, by Tagara, now Dowlatabad (Deoghir), and Barygaza, now Broach, to Pattala, now Tatta, near the delta of the Indus. Pattala was in communication with the port of Babarike, at the mouth of the Indus, and with Taxila in the Punjab, the Takhsasila of the Hindus, and evidently represented by vast ruins surrounding the modern Manikyala. It was near to this spot that Alexander crossed the Indus, and it was a place of great importance, as the place at which all the caravan routes in India and leading into India converged: for the route from Pattala was here joined by one from Palibothra, the modern Patna, the continuation of a line from China across the Himalayas; there, also, the different lines from Seres or China, through the Cashmere valley, and from Sarmatia (now Russia), Media, and Mesopotamia, through the Bamian and Kyber passes, first entered India. There was another route from Carmania (Kirman) through the Bolan Pass, connected with the route between Taxila and Pattala. Besides Barbarike, Barygaza, and Musiris, *viâ* Masalia, became great places of export, when once the sea was opened to the trade of India.

The caravan trade the Arabian merchants of Gerrha and Sabœa collected at Petra, the Edomites, or Idumæans, or Nabatæans, as they are later called, carried on into Egypt and Canaan, and the Phœnician Arabs distributed round the shores of the Mediterranean. Their chief cities, Sidon, Tyre, and Tarsus, rapidly became great. Sidon and Tarsus must have first risen into notice. Homer does not mention Tyre, but he constantly alludes to and describes the metal work, jewellery, and other art wares of Sidon. In the Sixteenth Book of the Odyssey he gives an exact description of the first meeting of the Greek farmers with the Phœnician merchants on the coasts and among the islands of ancient Greece, and of the manner in which the Phœnicians conducted their early trade in the Ægean Sea.

The Phœnicians of Tarsus found abundance of wood close at hand in Mount Taurus; the excellence of their ships gave them for a long time the pre-eminence in the navigation of the Mediterranean, and passed into a proverb. This seems to be the simple explanation of the expressions "ships of Tarshish" and "navy of Tarshish," so often recurring in the Bible, which still puzzle many people, who suppose that ships trading with Tarshish in Spain are meant. Homer's description of the first attempts of the Greeks to trade in the Mediterranean is a proof, says Dr. Birdwood, how commerce, in its

beginnings, is little better than piracy; indeed, it is very slowly that men discover that it is more profitable to get what they want by peaceable means than by violence and robbery and war; and still longer does it take them to learn the value of honest dealing in trade. In the Sixteenth Book of the Odyssey, the Greeks, who were not then as civilised as the Sidonians, are described as running up the mouths of the Nile, landing, and rapidly retreating to their ships with their booty. Thus the Greeks begun, as the Arabs before them, plundering where they dared, and, where this was impossible, trafficking, until they were gradually changed from wandering pirates into wealthy merchants and public-spirited and patriotic citizens; and Athens became the mother of arts and eloquence.

BREWING IN JAPAN.*

At the present time, when the history of the origin and development of the lower forms of life is occupying a great deal of attention, any facts which increase our knowledge of the growth of such bodies should be welcomed. In our breweries the growth of the yeast-ferment is tolerably well understood, or, at least, has been well observed and described. Under ordinary conditions the yeast-fungus exists only in the aquatic form, as it may be termed; and only under special circumstances, and with considerable difficulty in preventing putrefaction, is it enabled to produce spores. The internal substance of the cell become differentiated; granulations form and collect round certain points, and these ultimately become invested with a membrane, upon which the spores are ripe. The production of spores is thus unattended with the formation of a mycelium, or, if formed, it is so minute as to have been overlooked. This, however, is not a normal process of reproduction: the principal one, and, indeed, under the usual conditions, the only mode is by budding.

Those living in Japan, however, have the opportunity of seeing a mode of fermentation which differs in many particulars from that employed in Europe. The subject is now under investigation, and at present I am not able to explain accurately what takes place; but as the process followed is interesting from its novelty, since it appears to consist in the previous practical use of a discovery made by De Bary, and afterwards confirmed by Rees and by Fitz, that alcoholic fermentation can be effected by the growth of a species of *Mucor*, I am induced to give an account of a visit made, in company with some scientific friends, to the saké breweries situated about 30 miles away from Tokiô, the capital of Japan.

Saké is the general name given to the alcoholic liquid prepared by the fermentation of rice. There are many varieties of it prepared in different parts of Japan, each receiving some special name, either derived from the district in which it is prepared, or from some fancy of the manufacturer. It is a clear liquid, of a colour varying from the palest yellow to that of the darkest sherry, and containing from 12 to 15 per cent. by weight of alcohol. There are some special kinds which contain much less alcohol—from four to five per cent.—but they do not form the usual drink of the Japanese. It is almost always served hot, being placed in porcelain bottles, which are immersed in hot water, and left there until the whole has attained the proper temperature.

This liquid is prepared on the large scale only in certain parts of the country, the most famous district being that near Ozaka, one of the Treaty Ports. It is, however, often prepared on the small scale in private houses. The winter is the only season during which brewing operations are conducted, but this is not because the fermentation temperature is to be kept low as in the Bavarian method, but, I believe, in order to prevent the action becoming too tumultuous, for the temperature of fermentation is, in reality, even higher than that adopted in England. But, from the fact that the largest breweries are situated nearly 400 miles from Tôkiô, and the operations being carried on during a period when the University session is at its height, I have been compelled to confine my inquiries to the smaller breweries at Hachiôji, near this city.

The main room consists of a large wooden building about 120 feet long by 50 feet broad, and 25 to 30 feet high, running along the middle of which, in the direction of its length, is a platform about 12 feet from the ground, upon which some of the preliminary operation are carried out. Upon this a number of wooden tubs are placed, which serve for the preparation of the ferment, an operation which requires to be repeated several times during the brewing season. On the ground, ranged along the two long sides of the building are large tuns used for the storing of the saké when made, and some of which are also used for the actual processes of fermentation.

The brewing commences with the preparation of the ferment. For this purpose, at the end of the previous brewing season, a quantity of green mould is produced upon rice by exposing steamed rice mixed with a certain proportion of the ash of some tree, and over which the spores of this fungus have been scattered in a well-closed chamber) which I may term the "fungus-chamber." This is a small room, about 7 ft. high by 6 ft. broad, and 8 ft. long, well lined and covered with straw and matting, so that its high temperature may be kept up for a considerable time. In this chamber the rice and spores are left for about ten days, the atmosphere being kept quite moist by the vapour given off from the steamed rice, and at the end of that time the grains are found to be covered with a green fungus full of spores, and apparently the same kind as is found growing upon putrefying organic substances. The temperature of the chamber when examined was 25° C., that of the external atmosphere being 13°C. This product is called, in Japanese, *tane* or seed.

When prepared at the end of the season, it is preserved until the next by being placed in bags, and enclosed in wooden boxes, between layers of a mixture of equal parts of lime and wood-ashes.

When it is required to commence operations, a similar method is adopted to that just described; that is, a quantity of steamed rice is placed on wooden trays in the "fungus chamber," but not mixed with any wood-ashes, and then *tane* (spores) is scattered over it, and the chamber kept closed for a period varying from two to four days. At the end of this time the rice-grains are found to be covered with large quantities of fine hair-like threads, the mycelium of the fungus added. In this state it is called "kōji."

If this were left for a longer period in the fungus-chamber it would produce spores, and the brewer calls it "the friend of tane," but in order to carry on the development of the mycelium most vigorously, it is necessary to use wood-ash in addition, which thus seems to act as a fertiliser.

Having thus obtained the "kōji," or mycelium, the brewer uses it for effecting the preparation of his yeast. For this purpose he mixes steamed rice with 30 per cent. of its weight of "kōji" and a sufficient quantity of water to make a thick mud, in small shallow wooden tubs, which are kept on the platform previously mentioned. In these it is frequently stirred and rubbed round with wooden tools, during a period of about ten days, in the course of which the grains of rice appear to be broken down, and the whole assumes a much thinner consistence, while at the same time the liquor becomes decidedly sweet. This is a change which is anything but clear; it would seem that it is connected with the development of an organism derived from the "kōji;"

* R. W. Atkinson (of the University of Tokio, Japan) in *Nature*.

as on the small scale, I have noticed the production of minute cells, apparently budding, but whether they have any connection with the air-fungus, the mycelium of which covers the rice in "kōji;" or whether they have been developed from germs accidentally present in the "kōji," I am not able to say, though I hope that further experiments will make this point clear.

After the end of the ten days this product is mixed with the fresh-steamed rice, water, and "kōji," and introduced into larger wooden vessels, in which the mixture is heated by means of closed wooden tubs, containing hot water, and in order to prevent too rapid radiation, the whole is covered with matting. The hot-water tubs are replaced day by day, so that the temperature is kept up for a period varying from eight to thirteen days. The average temperature seems to be about 35° C. (95° F.). During this time there is a continuous development of gas, and a scum gradually forms upon the surface until it has a thickness of a little more than one inch, and, when examined under the microscope, presents the usual appearance of brewer's ferment—*saccharomyces*. At the end of this stage, if the operation has been well conducted, five tastes are to be distinguished: sweet, bitter, astringent, alcoholic, and sour; but of these five, all of which are quite distinct, the bitter, astringent, and sour tastes are most marked. The product of this operation is called "moto," which means "source" or "origin," referring to the fact that it is from this ferment that the saké is subsequently formed. All the previous part of the brewing process has thus had for its object merely the preparation of the yeast, but it is certainly the most interesting, from the obscurity which surrounds it.

The actual fermentation is divided into three stages, called respectively "beginning," "middle," and "end," the proportions of steamed rice and ferment varying slightly in each stage, but giving a final result of 100 parts of steamed rice to 30 parts of ferment. This mixture, together with the proper quantity of water, is placed in one of the large tuns before mentioned, and allowed to remain for about fifteen days in all, during which time fermentation actively proceeds, and the liquid becomes strongly alcoholic, at the end of which time it is drawn off from the grains of rice which have subsided, and introduced into other tuns, where it is allowed to remain to permit the remainder of the rice to be separated. The residue is placed in bags and subjected to pressure in a lever press, the clear liquid which is expressed being added to that which has been clarified. It is now placed in boilers and heated up to about 60° C., after which it is kept in the store vats, carefully sealed up.

The residue left in the press is subjected to a process of distillation in a current of steam, by which a spirit containing about 42 per cent. of alcohol is obtained.

The saké in the store vats contains about 15 per cent. of alcohol, and this fact shows that the fermentation is different to that effected by the *Mucor racemosus*, as described by Fitz. In his experiments he found that the presence of $4\frac{1}{2}$ to $5\frac{1}{2}$ per cent. of alcohol killed the ferment, whilst, in the process above described, we find the ferment acting in such a way as to produce 15 per cent. There is, however, nothing improbable in the supposition that different species may possess different degrees of sensitiveness to alcohol, and that the species used here may be less easily affected than the one employed by Fitz.

There are, however, many points about the process which are obscure, and about which I cannot say anything at present, but further experiment will, it is hoped, throw light upon the obscurity now enveloping the subject. The above account has been given in the hope that it may prove of some interest to those engaged in the study of fermentation, and that it may lead to a more extended examination of the action of various species of fungus upon amylaceous substances.

CORRESPONDENCE.

OPEN-MOUTHED PIPES *VERSUS* VENTILATORS.

At page 893 of your *Journal* for September 6th, Mr. Banner states that I ought to have mentioned the conditions under which the experiments were made as described at page 852, August 16th. It is somewhat curious, however, to find that he is rather reticent of the "chief conditions" of his own experiment, for he neither tells us the size of his own or the other cowls used, nor the height of the brick shaft. Perhaps he will yet favour us with these, and, in the meantime, with your permission, I shall explain the conditions under which my experiments were made. I used a 4-in. pipe carried up from the centre of my house in the upper flat, but the lower end of this pipe was contracted to 3 in., while experimenting, to suit the 3 in. anemometer I used. The entrance-door and all the windows were shut, except that four windows had each an opening in the middle all the way across, about 1 in. wide, to admit of fresh air, and there was only one fire on. These circumstances, and the condition of the atmosphere, caused a natural up-current in the ventilating-pipe all the time I was experimenting. Upon August 22nd, at 8 p.m., the weather changed, and in two minutes the following was the result:—

Plain 4-in. Pipe.	Trumpet Outlet.
75 ft. up	580 ft. up.
110 ft. down	15 ft. down.

The experiments described at p. 852 were made when there was little wind, and it is due to Mr. Banner to publish the following results when the wind blew harder. Each ventilator and the plain pipes got four minutes, and the whole amount of up-current of each was as follows, in feet:—

Plain Pipe.	Trumpet Mouth.	Boyle's Ventilator for 3-in. Pipe.	Buchan's 4-in. fixed Ventilator.	Banner's 3-in. Cowl.
800	1,400	1,200	1,960	1,350

In this case, Mr. Banner's cowl acted much better than the plain pipe, as it had the necessary motive power in the high wind to make it work; but during a calm this motive power is wanting,* hence its formation and its narrow outlet cause it to give inferior results. It is somewhat amusing to read the comparison drawn by Mr. Banner, at page 893, between his own 3-in. cowl and Mr. Boyle's fixed ventilator, and in which he takes care to tell us that the outlet area of the latter is much greater than that of the former; but as each is what the patentee sells, at the same price, as his size for a 3-in. pipe, Mr. Banner has himself only to blame if he makes the outlet area of his own cowl too small.

Mr. Banner is also displeased at the results stated in regard to his cowl not being so uniform as the others; but I cannot help the cowl in that respect, for, owing to the way it is balanced, it is somewhat erratic in its action, and thinks nothing of taking a waltz occasionally.

To-day I tried a new and different experiment, viz., to test the value of the ventilators in preventing a blow-down, or suck-down, of air through the ventilating shaft. I only allowed about half the former amount of fresh air to come into the house, and had

* Consequently, it is scarcely a proper comparison to compare a ventilating cowl with a Giffard injector, seeing that with the latter the engineer can apply the steam or motive-power whenever he pleases, whereas old Boreas will only blow when it suits himself, and is often sleeping when most wanted.

two fires on, and the following are the results in feet of up-current and down-draught in one minute for each :—

	Plain Pipe.	Trumpet Mouth.	Boyle's Ventilator.	Buchan's Ventilator.	Banner's Cowl.
Up	30	200	160	250	100
Down....	40	25	10	none	5

In addition to the foregoing I also tried the Archimedean screw ventilator, and found it to blow down as well as others, especially when moving slowly. In this case the screw blades merely churn the air and do no good.

Upon the whole I think the following conclusions may fairly be drawn from the foregoing experiments, viz., that a plain pipe is inferior to one with a trumpet mouth or expanding outlet,* while the trumpet mouth seems to be equal to various ventilators—including some of the most highly lauded—the situation and purpose having a good deal to do with which would be most suitable. Possibly in cases—such as for warehouses, &c.—where certain well-known ventilators have failed, the alteration of the shaft, with a metal or wooden umbrella would effect a cure. Then, in regard to preventing "down draught" into a house or enclosure with fires on in it, &c., which would tend to draw in a current from the outer air, a simple plain pipe is inferior to one with some suitable appliance surmounting it, especially when the wind is blowing.

I would be glad to see Mr. Banner's suggestion taken up, viz., to have a new trial of cowls, only I would like to see them tried against the plain pipe in a building with a fire or fires in it, and with apparatus to regulate the amount of incoming fresh air. I think, however, that Mr. Banner's idea of charging one hundred guineas from each competitor would tend to make the trial rather exclusive. From one to five guineas would be nearer the mark, so as to give poor patentees a chance as well as rich ones. Mr. Banner might subscribe his hundred guineas towards the expenses if he chooses. W. P. Buchan.

GENERAL NOTES.

Neilgherry Cinchona.—Pending the report of the committee which is to investigate and give its opinion as to the possibility of locally manufacturing the Neilgherry cinchona bark into a cheap febrifuge, the Government of India has, the *Times of India* hears, deputed Mr. King, the superintendent of the Botanical Gardens at Calcutta, who is in charge of the cinchona operations at Runghee, to visit Madras and the Neilgherries, and to lay before the Madras Government any explanation they may wish to receive on points of detail, with reference to the suggestion to manufacture cinchona alkaloids locally.

The Metric System.—Among the resolutions passed by the International Congress on weights, measures, and coins, at Paris, was the following :—"The Congress learns with pleasure the progress of the metric system ; it deplores that England, Russia, and the United States have not yet entered into the same path ; and it is of opinion that the Governments of those countries should be solicited to give effect as early as possible to an act of progress so eminently useful to science, commerce, and international relations." The British and American members had a separate meeting, and resolved to petition their respective Governments to appoint a mixed Commission to consider the adoption of the metric system by both countries, and to make all necessary recommendations for the proper legislation to secure the desired end.

* In my work on "Plumbing," chapter xxvi., "Flow of Water Through Pipes," published in 1876, reference is made to the large increase of quantity of water delivered when an expanding outlet was used, so I am not surprised that with air as the fluid a similar effect is produced.—W. P. B.

A Possible Industry for Cyprus.—We do not find that sugar is included in the list of agricultural products of Cyprus, although the statement has been made that it was formerly produced to a considerable extent in the island, but that the cultivation was stopped by a despotic Pasha who had personal objections to it, and therefore adopted the very thorough, though certainly arbitrary, remedy of having all the canes burnt, and of forbidding their being replanted. Whether this be true or not, the climate of the lower parts of the island would probably allow the sugar-cane to flourish; but to produce sugar cane profitably ample supplies of cheap labour are requisite, and Cyprus appears at present to be thinly populated. However, the tide of immigration provoked by the advent of British rule and security will soon turn the scarcity of labour into abundance. The favoured position of the island for purposes of trade would soon render it the sugar emporium of the Mediterranean. If there is reason to believe the soil be really suited to the cane, and if cheap labour be available, sugar planting should take root, for the industry, when started on modern principles, is so profitable that ample capital would soon be forthcoming to assist in its development.—*British Trade Journal.*

Our Consumption of Foreign Food.—Official returns show in detail the increase in the last ten years in our consumption of various imported articles of food. The consumption of foreign and Colonial wheat and wheat flour (the imports, less the exports) increased from 140 lbs. per head of population of the United Kingdom in 1867 to 203 lbs. per head in 1877. This last quantity is unusually large, but it is to be noted that it is now seven years since it was (in 1871) below 160 lbs. per head. The consumption of raw sugar has risen from 40 lbs. per head in 1876 to 54 lbs. in 1877, and of refined sugar from 3 lbs. to 11 lbs. ; of tea, from 3·68 lbs. to 4·52 lbs. ; of eggs, from 13 to 22 in number ; of potatoes, from 5 lbs. in 1867 to nearly 27 lbs. in 1877 ; and though this was exceptionally large the quantity has never fallen below 13 lbs. per head since 1871. The import of rice has risen from 6 lbs. per head in 1867 to 13 lbs. in 1877 ; of bacon and ham, from 2 lbs. to 8 lbs. ; of butter, from 4 lbs. to 5 lbs. ; of cheese, from 3 lbs. to 5 lbs. ; of tobacco, from 1·35 lbs. to 1·49 lbs.; of wine, from 0·45 gallons to 0·53 gallons. The consumption of British malt rose from 1·67 bushels in 1867 to 1·92 bushels in 1877 ; of imported spirits, from 0·28 gallons to 0·32 gallons, and of British spirits from 0·71 gallons to 0·91 gallons, showing an increase in the consumption of spirits from 0·99 gallons per head in 1867 to 1·23 gallons in 1877, this last quantity being less than in either of the three next preceding years. Coffee shows a decline from 1·04 lbs. per head in 1867 to 0·96 lbs. in 1877.—*The Colonies.*

Indian Woods.—The forests of India are stated to supply many useful and beautiful woods altogether unknown to commerce. On the authority of the Inspector-General of Forests, it appears that of about 2,000 kinds of wood grown in India, hardly 100 have been introduced to the trade, and it was quite time, therefore, that something was done to ascertain the commercial value of the unknown produce of our Indian forests. With this object in view a consignment of woods was recently despatched to this country from Calcutta, it being the first batch that has ever been sent here for sale by the Forest Conservancy Department. The woods have come over in irregularly shaped logs, some of very large size, and are very varied, so far as quality is concerned, for structural and manufacturing purposes. Thus, for instance, appeared among them such woods as box (*Buxus sempervirens*), olive (*Olea cuspidata*), the soft and apparently useless wood of *Alstonia scholaris*, as well as the woods of many other trees well-known for their fruits, resins, or other economic products, but hitherto unknown in this country, at least as timber trees. The collection was sold a short time since by public auction, and realised fairly good prices. It remains, however, to be seen whether the prices obtained were sufficiently remunerative to induce the authorities to send another consignment, for though the prices may have been moderately good as compared with those which usually prevail for similar woods, they may be prohibitive where the cost of transit is very great, for the remark made in the recently-issued Kew report regarding box wood applies equally to other woods, that "the difficulty of transit from the mountains to the seaboard appears to be the great obstacle." It is to be hoped, considering the vastness of our Indian forests, that such obstacles will in course of time be overcome.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,349. VOL. XXVI.

FRIDAY, SEPTEMBER 27, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

SOCIETY OF ARTS' MUSICAL SCHOLARSHIPS.

The examination for the Society's Scholarship at the National Training School for Music will be held at the School on Monday, the 30th inst., at 2.30 p.m.

PROGRAMME OF EXAMINATIONS FOR 1879.

The Programme for 1879 is ready, and can be had on application to the Secretary. The Society's Examinations now comprise the following divisions.

1. Commercial Knowledge.
2. Domestic Economy.
3. Fine Arts applied to Industry.
4. Music.
5. Technology of Arts and Manufactures.
6. Elementary.

A Pamphlet containing Specimen Examination Papers in most of the subjects is published, and may be inspected by intending Candidates in the Libraries of the Institutions in Union with the Society; or copies may be had on application to the Secretary of the Society of Arts, price 6d.

NATIONAL WATER SUPPLY.

HEALTH AND SEWAGE OF TOWNS.

The Reports of the Congresses on the above subjects have been published in pamphlet form, and each report can be obtained at the Society's House, price 2s.

The Council of the Society of Arts are endeavouring to prepare a complete list of all the Reports of Medical Officers of Health which contain references to water supply. They will be much obliged if Medical Officers will communicate the dates of such reports, and, if convenient, send copies to be preserved in the library.

CANTOR LECTURES.

SOME ORIGINAL RESEARCHES ON PUTREFACTIVE CHANGES AND ON THE PRESERVATION OF ANIMAL SUBSTANCES.

By Benjamin Ward Richardson, M.D., LL.D., F.R.S.

LECTURE I.—DELIVERED MONDAY, APRIL 8.

I propose, in this course of lectures, to bring forward for your consideration a series of original observations which for many years past have been a part of the work of my life. In the study to be placed before you, two subjects will be included. They are, in themselves, distinct subjects, but they naturally combine, and one can scarcely be taken into account without the other, for, indeed, the one suggests, and is the practical outcome of the other. The subjects are:—

(*a.*) The nature of that change in dead organic animal matter which we call putrefaction, or fœtid resolution of dead animal matter.

(*b.*) The conditions under which the putrefactive change is for a time arrested or prevented altogether.

In following up my design, one of two courses lie before me in relation to the treatment of the questions that will come forward for solution. From the facts I have been able to collect, I could fill up all the time that is at my disposal by treating upon the theory of putrefaction, and upon the views that have been, or that may be, adduced, as to the cause and nature of putrefactive changes. From the same facts I can equally well fill up the time by describing the practical side of the subject, that is to say, the most ready and simple scientific methods for arresting or preventing putrefactive changes, and for making the knowledge that has been obtained on that point available for the practical requirements of mankind.

It seems to me that in a Society such as this, the practical side of the question is certain to be most appreciated. For although the theoretical is deeply interesting, and at the present moment is of special interest, owing to the many contentions that have recently arisen upon it, the practical study accords more decisively with the objects of this Society, one of which has long been cherished, that of mainly helping to bring forth a cheap, a certain, and a perfect mode of preserving animal food, so that it may be carried in the fresh state from one part of the world to the other.

I decide, therefore, for the practical study of the subject in hand as the primary object of these lectures; at the same time much will, by necessity, be introduced bearing on some of the theoretical questions which may fairly come forward in connection with the investigation of means for the prevention of putrefaction. I shall, indeed, advance a theory of my own, which, according to the light of experiment as it affects me, is a rational explanation of much that hitherto has been obscure. But this and all else will be subsidiary to the practical inquiry—how best to preserve dead animal matter.

HISTORICAL DEVELOPMENT.

The history of the science and art of preservation of animal substances is worthy of a first and

preliminary description, brief as it may be, because it suggests, *in limine*, the bases of all the principles of research, up to the latest, that have been carried out. In the most ancient order of investigation there is a true and natural mode of work in all that relates to principles, however rude and incomplete the details of the labour may seem to us, who have now at command refined and systematised plans, chemical and mechanical.

In past methods three objects have been had in view. These have been—1. The preservation of the human dead. 2. The preservation of the bodies of the inferior animals, or of parts of the bodies of those animals, for the purposes of food. 3. The preservation of parts of animals, or of rare animals, for purposes of science. The three subjects are described under the terms embalming; preservation of animal food; preservation of specimens for the museum. On the first and last of these divisions I shall touch very shortly. To the second I shall devote the larger amount of attention.

THE SCIENCE AND ART OF EMBALMING, ANCIENT AND MODERN.

It has been urged against the art of embalming in modern days that it is an objectionable and unnecessary art. I agree that it is not often necessary to practise it, but it is not true to say that, when it is at this time properly carried out, it is actually objectionable. It is not more objectionable than the performance of a *post-mortem* examination, and, like that scientific procedure, it is on some occasions of service, as I shall indicate in the proper place.

The ancient methods of embalming, when compared with the present, were singularly rough and laborious. The ancients devoted days to a task which we can, under urgency, carry out in as many minutes. It may occur to some minds which hear this statement that the old processes of embalming are, therefore, of no moment, and that it would be waste of time to consider them ever so casually. It has been to me a most useful study to read back those ancient plans, for in them is to be found the principles of preservation all carried out in their fullest perfection, rudely it is quite true, but still perfectly in respect to results. For the history of the art of preservation by embalming we have a record written four hundred and eighty four years before the commencement of the present era, that is to say, a record of two thousand three hundred and sixty-two years. This same record relates to a process which had been carried out, in practice, long before the historian penned his description, so that when we speak of embalming we speak of one of the earliest arts of civilisation.

Embalming, as we read of it, could only have been carried out by a civilised people, a people that had some knowledge of anatomy, and a certain crude, but practical, knowledge of chemistry. Herodotus, who himself must have studied the details of the art with close observation, states that there were in Egypt in his time certain persons who were specially appointed as embalmers, and who professed the art. Some have looked on these professors as priests, others as physicians: it is probable they followed both avocations. The embalmers, when their services were called for, showed the friends of a deceased person a wooden model, painted so as to represent as nearly as possible the original. The models were of three different values, and apparently of different solemnities. "The most perfect of the models," says Herodotus, "is asserted to be the representation of him whose name I take it to be impious to mention in this matter." The second was less finished, and the third was the meanest of all. The relatives had to declare which of the models they chose, and they chose according to the price they undertook to pay. Then they retired, and left the body of their deceased friend with the embalmers. The embalmers commenced their proceeding by extracting the brain of the dead person from the cavity of the skull, through the nostrils, by means of a bent iron (a hook in common parlance), and by the infusion or pouring of certain drugs into the cavity of the skull. In these ways they removed the brain without disfiguring the head or face, an operation which may seem difficult, but which, practically, would present no real difficulty at all when a little experience in operating had been acquired. The contents of the skull removed, the abdominal cavity was next opened with a sharp Ethiopic stone, and the intestines were removed. Herodotus does not tell us what was done with these internal parts, but the information is supplied by Porphyry, who states that the intestines were put into a chest, and that one of the embalmers having offered up a prayer for the deceased, addressed the sun, the purport of the address being to signify that if the dead man during his lifetime had been criminal, it must have been on account of these parts. Then pointing to the chest or box containing the parts, it was thrown into the Nile. The story is of singular interest, as indicating how early in the history of man the idea became prevalent that the passions had their seats, not in the reasoning brain, but in the bowels. This, by the way. The narrative of Herodotus goes on to describe that, after the cavity of the body was emptied of its natural contents, it was charged with powder of pure myrrh, cassia, and other perfumes, but not frankincense. The body was then sewn up, and covered with nitrea and natron for the space of seventy days, which time might not be exceeded. At the end of that period the body was removed, washed, and closely wrapped in bandages of cotton dipped in gum, which the Egyptians used as glue. It was now returned to the relations, who enclosed it in a case of wood, made to resemble a human figure, and it was placed against the wall in the repository of the dead.

In the above account the most costly mode of embalming is described. A second and less expensive process was performed without emptying the cavities of the body at all. The intestinal cavity was injected with cedar oil, and the whole body was afterwards covered with nitre for seventy days, as in the first instance. The third and least expensive process of all was simpler still. The inside of the body was washed with a solution called syrmaca, and then the body was covered with the natron for three score and ten days. The nature of syrmaea, or, as some spell it, surmia, is not known. It was probably an aromatic solution. Another account of the process of embalming practised by the Egyptians is rendered by Diodorus Siculus, who lived 450 years later than Herodotus. Substantially his record confirms what was said by Herodotus; but he

(Diodorus) states that the man who, in the embalming operation, laid open the body with the sharp stone, the cutter or dissector, was obliged to fly as fast as he could after he had made the incision, for those who were present ran after him, and cast stones at him, and cursed him, throwing all the imprecations which they thought belonged to his office upon himself. Hence it is supposed came the saying used in our University sportive language, "cut and run."

The bandages in which the embalmed were enrolled were of cotton, and the glue is believed to have been a solution of gum arabic. The late Mr. Pettigrew, who unrolled many mummies, and to whose learned work I am indebted for much instruction, is of opinion that, before the bandaging was carried out, the cuticle or scarf skin of the body was peeled off, the nails being carefully preserved. The nails were sometimes gilded; these nails and the hair were well preserved.

Much dispute has been maintained on the point of what were the materials which the ancient Egyptians used for preserving the embalmed bodies. Mr. Pettigrew infers that two distinct orders of embalmings were carried out; one with a balsamic substance, and the other with natron, or nitre. Those mummies, he says, which are preserved by balsamic and astringent preparations, are filled with a mixture of resin and aromatics, but others are filled with asphaltum, or pure bitumen. Those filled with resinous substance are, he states, of an olive colour, the skin dry and flexible, and, like a tanned skin, retracted and adherent to the bones. These mummies are "dry, light, and easily broken." "The resinous substance in them has no particular odour, but when it is burned it gives out a strong aromatic smell." The mummies which have been filled with bitumen are black, and the skin on them is hard and shining, as if it had been covered with a varnish. The mummies are dry and heavy. They emit no odour, and are difficult to break. They have been prepared with great care, and are very little susceptible to decomposition from exposure to the air. In both sets the features are perfect.

We may now, I think, safely assume that in both these classes of preserved bodies the preservative was one or other of the antiseptic substances, which, in these days, are separable from the crude bituminous products used by the ancients. In the resinous and aromatic specimens, such an aromatic substance as benzoic acid, which is a powerful antiseptic, was, in all probability, the basic antiseptic. In the bituminous specimens, naphtha was probably the preserving agent, for which purpose, as will be seen by a specimen of preserved animal substance we have before us in which it has been used, it is admirably adapted.

The bodies which were preserved by the salting process, that is to say, by immersion in natron, are worse preserved than those which are wholly or in part treated with bitumen or asphalte. Pettigrew says of them that the skin is dry, white, yielding no odour, but easily broken. The features are destroyed, the hair is entirely removed, the bones are detached from their connections, and they are white like those of a skeleton. The cloth enveloping the bodies falls to pieces upon being touched.

Many learned scholars have descanted on the question whether the saline substance called "natron" was really nitre, saltpetre, or some other saline material. In certain cases the evidence seems satisfactory that nitre was present in the mummies, and nitre, we know well, is a poweful antiseptic. But in the greater number of instances the substance was common salt, mixed with sulphate of lime, in small quantities. The late well-known chemist, Dr. Ure, made an analysis of a quantity of the salt collected from one of Mr. Pettigrew's Græco-Egyptian mummies, and found it to consist mainly of culinary salt (chloride of sodium).

Later in time other substances were employed in the embalming process, and even the sugars came into use. Honey was employed for this purpose. Alexander's dust, before it filled the supposititious bung-hole, was preserved in honey. In this manner it was probably deposited by Ptolemy in the coffin of gold in which it was enshrined in the Temple at Alexandria, until the coffin of gold was stolen, and the remains were transferred to a coffin of glass; perchance some day a learned antiquarian may find those remains in that coffin of glass, and look on them with almost as much awe as the Egyptian embalmers who were first called to see them, and scarcely dared to touch them.

Herodotus tells us of another mode of preserving the bodies of the dead. He says of the Macrobian Ethiopians that they extracted the moisture from the bodies of dead, and then covering each body with a kind of plaster, they decorated the plaster with various colours, so as to imitate the dead as closely as possible. Then they enclosed the form in a hollow pillar of crystal, and placed it for twelve months in their houses. The process led to the story of preservation of dead in pillars of crystal.

Upon these ancient methods of embalming no marked improvements were made, as far as we know, until quite modern times, although there were great variations. The Guanches, who lived on the Canary Islands, washed the body for four days with water, anointed it afterwards with butter, and covered it with a powder composed of a dust of pine trees and brushwood, called "Bressors," with pumice. Finally, they wrapt the body up in leather, and placed it in a cave. A specimen of a body preserved by this plan is in the museum of the Royal College of Surgeons.

Preservation of the dead by the simple process of drying, or desiccation, was practised by some communities. The Peruvians desiccated the bodies of their dead in sand. In Palermo, a convent of Capuchin Friars suspended numbers of desiccated bodies of their fellows in galleries. Captain Smythe, who visited the convent in 1624, reported that the bodies of two thousand had been so preserved in the convent. A few years ago some bodies that had been long preserved by desiccation were exhibited in London.

The Burman priests used for embalming purposes methods which varied but little from those of the Egyptians. They removed the contents of the abdomen, charged the cavity with spices, and covering the body with wax or resin, finally gilded it. In the monastery of St. Bernard, so well known to travellers, the bodies of dead persons who have died in the mountains from cold are preserved by two natural processes, the extreme

cold and slow loss of water-desiccation. These bodies are free of putrefactive changes, but they lose form and become shrunken from the loss of water.

If, now, we consider the lesson that has been taught by the embalmer's art, we learn that three distinct methods of preservation were thereby discovered, namely, preservation by the employment of antiseptic substances; by the plan of removing water—desiccation; by the action of cold. Up to the present day no new principle has been added to the art; it has been improved in its details, but on the same bases.

The Egyptian method of embalming continued chiefly in repute for centuries upon centuries. It was simplified and modified, but not materially departed from. It was not until the time of the anatomist Ruysch, who was a contemporary of Peter the Great, that any important change of detail was introduced. Ruysch conceived the plan of injecting preservative fluids into the dead body by the blood vessels. The plan has been adopted for another purpose of late years, as if it were a new invention, and has, I believe, been made the subject of a patent: it is not new at all. Ruysch carried the art of preserving by injection to such perfection that his specimens were the wonder of the time in which he lived. It is recorded that Peter the Great, on seeing the dead body of a child which Ruysch had preserved, did not detect that it was dead, and kissed it. It was also said that by the method adopted the colour of the body was maintained, and the form and suppleness of the limbs, but for what length of time these conditions were present we have no account. As none of the bodies so preserved remain entire, to testify to the perfection of the Ruyschian method, we must, I fear, accept some parts that are declared of it with the grain of salt. The inventor died, leaving a wonderful set of injected portions of the body behind, by which anatomy was greatly benefited; and we may perhaps honestly consider him to have been not only the inventor of the plan of treating by injection of preservative fluids, but the most skilful injector who has ever lived. He was selfish enough to depart from the scene of his labours without communicating his secret, whatever it was, to any one. The improvement he made is, therefore, lost, except in respect to the method of using the preservative by the process of injection.

William Hunter followed Ruysch in the plan of passing a preservative fluid into the dead body by the blood vessels. He injected by the arteries, selecting generally the large artery in the thigh called the femoral, for the vessel into which to insert the nozzle of the syringe. His presevation of the body of the wife of the eccentric Martin Van Butchell was one of the curious events of the latter part of last century. The embalmed remains of the lady are still retained in the museum of the Royal College of Surgeons, and prove that the embalment, which was rather a prolonged and complicated affair, was successful in preventing putrefactive decomposition. Dr. Baillie followed Hunter's method, but also injected his preservative into the cavities of the body.

The formula for Hunter's embalming solution is —Venice turpentine, one fluid pint; oil of lavender, two fluid ounces; oil of rosemary, two fluid ounces; oil of turpentine, five pints.

Hunter's method was afterwards practised by Dr. Matthew Baillie, with this variation, that instead of removing the intestines or other viscera, he (Baillie) injected the preserving fluid into the stomach and rectum, and into the lungs by the windpipe, after he had thrown the solution round the whole of the body by the arteries. A surgeon, named Sheldon, also carried out a similar method, except that he used for his preservative camphor dissolved in spirit, in the proportion of one ounce of camphor to six ounces of spirit.

According to Mr. Pettigrew, Mr. Madden succeeded in bringing home, by sea, the body of a youth, from Naples to London, preserved in tar. The voyage, which was long and perilous, lasted 72 days, but the success of the experiment was complete. In this case the viscera were removed from the cavities, and were coated with tar. The visceral cavities were also coated with the same. The external surface of the body was covered with a tarred sheet.

The plan originated by William Hunter held its place, with very slight modifications, for several years. Joshua Brookes, the last of the great English anatomists, who had a distinctive school of anatomy of his own, practised this method.

The next change of the process was made in France, by M. Boudet, who introduced the use of corrosive sublimate into practice as the preserving agent. This experimentalist followed very closely the method of the ancient Egyptians, only that he employed a different agent for preservation. He laid open the large cavities of the body, incised the viscera, and covered them as well as the walls of the cavities with an alcoholic solution containing bichloride of mercury. After this, he added a layer of varnish, and then filled up the space remaining in the cavities with aromatic powder. He next sewed the incised parts neatly together, and, having varnished the whole of the skin, powdered it with aromatic substance, covered it with several bandages, and over the bandages spread another layer of varnish.

With Boudet the system of simply treating the inner and outer surfaces of the body with the preservative died out altogether. It was superseded by the process of Tranchina, who followed Hunter in injecting the arteries, but who employed a different fluid substance for injection.

Tranchina first made use of a substance that had to be heated to become fluid, and which became solid on cooling. After a time he gave up this plan, and simplified it by using a simple solution composed as follows:—Arsenic, 2 lbs.; cinnabar, (for colouring), 1 oz.; spirits of wine, 20 lbs., by weight. This solution was injected through an artery until all the tissues were charged with it.

After Tranchina, M. Gannal introduced a solution, to be used in a similar manner. He held the composition of the solution as a secret, but it was soon discovered to contain arsenic. The practice of embalming with these arsenic solutions having become common in France, the Government of Louis Philippe issued an order in 1846, declaring that the sale of arsenic, and of all compositions containing it, were prohibited for soaking grain, for the destruction of insects, and for the embalming of bodies. Later, the use of corrosive sublimate was, in like manner, interdicted.

In 1847, Gannal, maintaining that his preserva-

tive did not contain arsenic, but was a saturated solution of equal parts of sulphate of aluminum, and the chloride of the same metal, a Commission of the Academy of Medicine was appointed to inquire into the subject. A solution presented by the inventor was examined, and found to contain arsenic, whereupon it was excluded from public use.

The injection of sulphurous and carbonic acids into the arteries in the form of vapour—the acids being produced by the quick action of sulphuric acid on charcoal—was suggested by a chemist named Dupré, but the results were not favourable.

Another suggestion was by M. Robiere, who proposed to use rectified wood spirit in which camphor had been dissolved, as the preserving solution. This was clearly a return to the plan that had already been carried out in England by Sheldon, and that it did not prove satisfactory in Robiere's hands is indicated by the fact that he recommended it should be supplemented by the application over the body of a coat of varnish.

When I was making a visit to Paris in the year 1867, I was shown portions of a lady which had been preserved, I was told, by some process which had never been revealed. In this subject the muscles of the arms and thighs had been dissected out with considerable care, as for anatomical purposes, and they were in a state of remarkable preservation. They were also naturally supple, and yet sufficiently firm to admit of being handled. They felt to the hands greasy, but they left no stain on the skin nor unpleasant odour. The most objectionable part was that the whole of the structures thus preserved were as black as ebony, and refused, I understand, to receive any colouring principle that would give the idea of natural appearance. I was informed by the exhibitor that this process had been used for embalming, and that from the circumstance of its leaving the whole body supple as well as fresh, it was exceedingly effectual; but that the objection made to the colour prevented its successful introduction into practice. From the general appearances, I came to the conclusion that the secret preservative used in this case was nothing more than sulphuric acid, and I afterwards made some experiments of injecting the vessels of a dead animal with sulphuric acid slightly diluted, which showed to me that the supposition was perfectly correct. The muscular structure in these instances seems as if it were partly charred, but it remains quite flexible, owing, I think, to an after absorption of water by the acid from the atmosphere. For the purpose of embalming, this process as it now stands, is inapplicable, but if by any means the muscles preserved by it could have a fleshy colour communicated to them, it would be an invaluable method to the demonstrator of anatomy, since by its means he could preserve careful dissections of the natural parts for many years, ready at any moment for demonstration.

In the year 1854, I made the observation that if liquid ammonia were brought into contact with dead animal structures, it would hold them for a long time in a state of perfect preservation. In this way, in a closed box, I preserved for a great many months numerous finely dissected specimens, and used them from session to session for purposes of demonstration. I also injected ammonia into the vessels of dead parts, in order to make it applicable as a preservative; but I do not think it would answer as a fluid for embalming so well as some other fluids, although for temporary preservation it leaves little to be desired. The objections to it as a permanent preservative are twofold. In the first place, it is itself evanescent, and so it readily diffuses away from the tissue it is intended to preserve. In the next place, when it is long in contact with the tissues, it transforms them in so remarkable a degree that they cease to retain their original character. The fatty matter passes into the condition of a soap; and the muscular substance assumes a gelatinous appearance, loses its natural colour, and separates from other structures with which it is combined. At the same time there is no trace of putrefaction.

Simple wood vinegar has been used by some embalmers for injection of the vessels. This application came from an observation made in 1833 by the distinguished chemist Berzelius, who examined a body that had been kept by this means in perfect preservation for twenty years.

At the time when M. Gannal's process was before the Academy of Medicine, M. Sucquet presented a preservative solution for embalment that was free of arsenic. It was a solution of chloride of zinc. Experiments were made by the academy with this solution, and with Mr. Gannal's sulphide and chloride of aluminum solutions. Two bodies were embalmed, one by Sucquet's, the other by Gannal's process. The bodies were buried for one year and two months, when the one embalmed by M. Gannal had undergone putrefaction, while the one embalmed by M. Sucquet was in perfect preservation. Exposed to the air, the latter dried without the least putrefaction, and acquired a degree of hardness comparable only to that of wood or stone.

Sucquet's method has been most extensively used, both on the Continent of Europe and in America. I have used it several times, and, although it admits of great improvement, it is, on the whole, the best preservative system known for embalming purposes by the process of injection.

Embalming at the Present Day.

Embalming at the present day is, in England, an exceptional process, and when we are called upon to perform it here, it is, in ninety-nine cases out of the hundred, for some one foreign to our country. I have embalmed many bodies, but only in two or three instances the bodies of English. In these exceptional instances the deceased, although they were born and died in England, had lived the greater part of their lives abroad, and were embalmed in order to be conveyed to friends at a distance, who wished to bury them. In the United States of America the embalming process is carried out to a great extent, and I believe the number of persons embalmed in that country increases every year. Hence, Americans who are residents here often ask to have friends or relations embalmed.

The reasons assigned for embalment are numerous—some are valid, some perhaps fanciful. In most cases in which I have been consulted, the object of the embalming has been to retain the body free of putrefactive change long enough for it to be conveyed from the place where it died to some distant

place where it is finally to be entombed. This object is in every sense reasonable. In other examples the embalming has been sought after that the relatives may retain the dead body as long as they can with the face exposed to view. For such purpose coffins of a special kind have to be made, in the lids of which a pane of glass is placed. In England these receptacles for the dead are not often constructed; but in America they are specially constructed, and I learnt that one body which I embalmed in England was, on its arrival in America, transferred to the particular receptacle described, in which (with the face perfectly preserved) it is retained. I offer no opinion as to the value of embalming. The question involved in it is one entirely of feeling. I may only add that the process is harmless to everybody; it involves, I mean, no breach of sanitary rules if it be properly carried out.

Once I knew the embalming requested from the last direct wish of the deceased, who feared unless this precaution were taken she might be buried alive. It was not necessary, of course, to embalm to insure against that terrible calamity, but the desire had to be carried out. The lady was afterwards buried in the usual way.

Embalming is sometimes performed on distinguished persons as a supposed mark of distinction. For ages upon ages this intention has been acted upon, and has become, in a certain sense, a fashion. Probably, if the distinguished personages who were embalmed with so much care in ancient Egypt could have foreseen to what base uses their preserved remains would in the course of time come—that they would stand, in fact, as the shows of another civilisation—they would have been anxious to have been consigned at once to the earth after their deaths, or even to have been resolved on the pyre. Yet to this intention of embalming there are two sides. To the historian these remains of what once were mighty men possess an interest of no mean character, and he who would wish to trace the correct line of the Pharoahs, regrets, I doubt not sincerely, that the embalmers of these royal personages were not more successful in their art. It must be admitted, however, that this object of embalming has been abused. To embalm a distinguished man that he may lie for long periods in the embalmer's room to be stared at by multitudes of people as a pseudo-scientific sight, is a degradation of scientific labour.

Occasionally, the art of embalming may prove of service for the benefit of the public—that is to say, for the promotion of public justice. It may be necessary to embalm a body in order that it may afterwards be identified; or it may even be necessary to preserve the whole or parts of a dead body in order that it, or they, may be submitted to analysis or other mode of investigation.

There is yet another object for the public good in which the skill of the embalmer is useful. There are circumstances when it is not possible to bury a body immediately, and where it is necessary to keep it in such a state that it will undergo no decomposition, nor be calculated to be injurious to the living who are near to it. Here it is of moment to know how temporarily to check the decomposition and prevent the diffusion of poisonous gases from that source.

I have dwelt for a few moments on these subjects of embalming, without minutely arguing any point that may be raised upon them, in order to show that the art is one that is demanded on various grounds, and is not likely to fall out of demand. As this is the undoubted fact, I think it is right for medical men to retain and even to cultivate the most perfect knowledge of the art. If we do not scientifically carry it out, other men, mere empirics, who know nothing either of chemistry or of anatomy, will attempt to do so, and the public will be alike defrauded, and an art, which really rests on the purest basis of science, will be brought into unmerited disrepute.

There is nothing so difficult in the process, but that any practitioner can perform it as easily as he can perform a *post-mortem* examination; and when he has before him the simple rules I shall lay down, he will find the task easy. One quality only does it call for, and that quality is patience. It is true that in these days we are rapid to a marvel when we compare ourselves with our old friends, the Egyptian embalmers. We require hours where they required days; but still, to do the thing well, some considerable patience is demanded even now, notwithstanding all our modern knowledge and modern appliance.

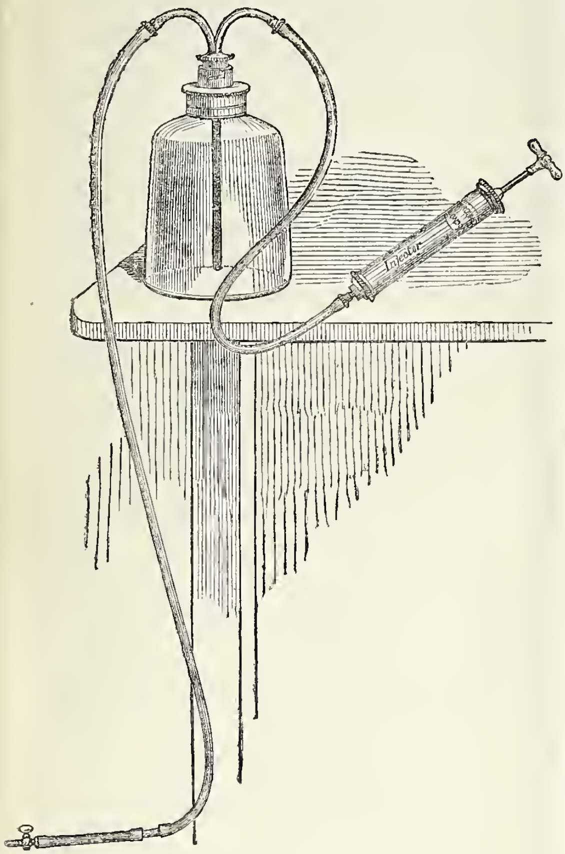
The Modern Method.

The modern method of embalming is very rapid and simple when it is compared with the ancient.

A large artery of the dead body is exposed and opened, and into the vessel a hollow needle is inserted. The needle is firmly tied in its place. Through the needle a solution of chloride of zinc is injected slowly until it has found its way over every part. The principal art that is required in this process is to be very careful not to use too much force in driving the fluid into the tissues, and in not using too much fluid. The fluid which answers best is made as follows:—Into two pints of water, at 50° Fahr., add chloride of zinc slowly until the water just refuses to take up any more of the salt. Then add one pint of water more, and two pints of methylated spirit. The five pints so produced are a sufficient quantity for embalming an adult body. The solution can be injected quite cold, and it will find its way readily over the vessels. If expense be not considered, pure alcohol may be used instead of the methylated spirit. The effect of the solution is shown by its making the surface of the skin white, firm, and, for a short time, slightly mottled. The apparatus necessary is extremely simple, and lies on the table. It consists of a small ordinary anatomical case, and of an injecting bottle and syringe, which has been constructed on my directions by Messrs. Krohne and Seseman, of Duke-street, Manchester-square.

The diagram shows the apparatus ready for use. The bottle will hold six pints of fluid, but it need not be quite filled. The neck of it is fitted with two tubes, which make it act like the common wash bottle of the laboratory, so that when, through the tube on the right-hand side, air is forced through the syringe which is attached to the tube, the pressure on the surface of the fluid forces the fluid up the long tube in the bottle, and over the tube on the left-hand side. The left-hand tube terminates in a stop-cock, to which the needle that has to be inserted into the artery is joined. The

tube leading to the bottle is of india-rubber, of an eighth of an inch bore, and may be several feet long. Before the arterial needle is tied in the artery, the stop-cock is turned off, that no fluid may pass. When the needle is fixed the stop-cock is opened, and the bottle is raised on a table three



feet above the level of the lower end of the injecting tube. As a rule, the fluid will now descend by its own weight, and gravitate all over the body, but if it fail to do this, the pressure of the syringe for a short time will be sufficient to carry on the current.

When the fluid has slowly diffused, until it has been all passed into the vessels, a pint of solution of silicate of soda may be injected with a syringe through the artery, by which the structures will be rendered very black; the silicate undergoing a firm coagulation in contact with the zinc. This final plan is, however, not really required. It is, as a rule, merely necessary to remove the hollow needle from the artery, tie the artery above and below the place where it has been opened, and merely close the opening that has been made. The operation is now complete. There is nothing in it of a kind to give rise to any of the sensational stories which have been raised in regard to it, that is to say, when it is properly conducted. It is not more objectionable than the ordinary examination of a body to discover the cause of death.

Desiccation.

In treating of embalming processes, I must not omit to mention that, in our modern days, the process of desiccation has been very skilfully and practically applied for the temporary preservation of the dead. M. Falcony is the inventor of this plan, which consists in the temporary burial of the dead in a fine sawdust, charged with a salt which has a great affinity for water. Sulphate of zinc is, I believe, the salt that answers the purpose best. Many years ago, I had the opportunity of seeing M. Falcony carry out his method, and it answered thoroughly. In cases where those who have died from infectious disease, cannot be at once buried, Falcony's plan serves an all-important hygienic purpose. It is also most practical in instances where deceased persons have to be removed some distance for burial, or where other circumstances demand a delay in interment.

Preservation of Museum Specimens of Animal Structures.

Museum specimens are preserved usually by fluids, which are either injected through the vessels of the structure, or made to surround the structure altogether. Alcohol is, as a rule, the preservative basis in all these cases. To the alcohol various other preservatives are added; I may say, almost without any rule whatever of a fixed kind. In the museums I have visited, I have found every man with his own plan, and some with a great deal of mystery added to the plan, which he could not or would not explain. Boudet and Tranchini's spirit solutions hold a prominent place, or some modifications of these. I have already supplied the details of their composition. One of the Munros, of Edinburgh, I think it was the one called Munro *secundus*, introduced a solution which is very useful and effective for injection. It consists of a mixture of nitric acid and pine spirit, in the proportion of one part of the acid to six parts of the spirit. In our time, Mr. Savory has introduced an aqueous solution which is very good, and which is composed of five grains of the bichromate of potassa dissolved in every ounce of water. Budge uses a solution for moist preparations composed as follows:—Pyroligneous acid, a fluid ounce; sulphate of zinc, an ounce; water, eight pints. This is an excellent solution, cheap and effective.

For the preservation of dry preparation, solutions of corrosive sublimate and alcohol have been most in use. The specimens are dipped and dried. Solutions of arsenic have found favour for the same purpose, but are less steady in action than those made with the sublimate. In some museums we still see specimens prepared by what was once called the "corrosive process." It is a plan that is not often used now, but many of the best preparations of membranous textures have been set up by it. The specimen was first injected with spirit, or with spirit, wax and vermillion. Then it was immersed for a month in a bath composed of four parts of hydrochloric acid to one of water. After this immersion the specimen was removed, washed and dried.

Preservation of Animal Substances for Food.

The processes which have been adopted for the preservation of foods derived from the animal

kingdom have, up to the present time, from the earliest times, been largely based on the same principles as those we have already discussed. Three plans have been adopted:—(*a*) Removal of the water of the structure by drying—desiccation; (*b*) exposure of the substance to be preserved to antiseptic substances; (*c*) exposure to a low temperature; and these, with modifications of detail, have been the only plans followed for preserving the animal structures in their fresh state. A method of a novel kind has been successfully employed during the last half century for the preservation of cooked foods, namely, by exhausting the air from them and by sealing them up in air-tight tins, after the plan invented by M. Appert and perfected by Fauster. With this system I shall not have occasion to deal, as it does not refer to preservation of uncooked animal substance, but I name it to indicate that it is not forgotten.

Of the three methods employed to preserve fresh food, that by drying or desiccation is considered by many good authorities to be the oldest.

The drying and preservation of corn and fruits would be the first step taken by man in this direction. This would specially be the case in reference to the products of the cereals, for of them their consumer would soon learn the great and striking fact, that if a portion of their seed were not preserved, and on cultivated ground re-sown and properly tended, the supply would fail, no accidental sowing or distribution of seed keeping it up. Upon this form of preservation followed very probably the invention of preserving milk in the form of cheese, which invention, according to Justin, came from a personage no less early in the arts of civilisation and life than the demi-god Aristæus, the veritable son of Apollo, and king of the Arcadian realm.

M. Paggiale supports the opinion that the most ancient method of preserving food consisted in the practice of drying, or desiccation, and adduces the fact that, in savage nations, at the present day, it is the universal practice, that it dates with them from their earliest traditions, and is, in fact, the only process known and recognised. The plan adopted for desiccation was also, he thinks, of the simplest character, the substances to be preserved being exposed only to the influence of the sun and the air. In support of his hypothesis, M. Paggiale quotes the authority of the eminent Boussingault, who, in his travels, has spoken to some negroes of Choko who had never seen the ox, but knew the flesh of the ox as food in the form of dried flesh. This learned chemist, indeed, supported himself for nearly three years on dried meats while living in the mines of La Vega, during his excursion to the gold and platina diggings. The meat thus dried is hard, and forms in itself an unsavoury and indigestible food.

It may seem strange that an assertion such as has here been quoted should be received on the authority of a single traveller; but if there is one man more than another whom we may accredit as a traveller, it is Boussingault. Too acute to be deceived, and too simple to offer a word of deception, we may believe his statement, when we recall that Choko, placed south of Darien, and watered by the San Juan and the Atrato, is covered with dense forests, through which the air finds no circulation, in which a fertile soil yields abundance of maize, but on which the breeding and growth of animals for the food of man become virtual impossibilities.

But, accepting the view that the process of desiccation, or mere drying, is primitive as an invention, we are soon led to another food-preserving process not far behind this, or, at all events, very ancient; this is the salting process, or the mode of applying common salt to avert putrefaction. It has been urged that the use of this method implies, in matter of history, such a degree of knowledge as would indicate an advancing civilisation, and even some acquaintance with the simpler details of chemical science and art. I think this a reasonable view; and certain it is that, whenever in history we read of the method of preserving animal or vegetable substances by the plan of dressing them or of saturating them with salt, we detect that the operators lived in an age when the refinements of civilisation, and the cultivation of the useful arts, had reached a degree of perfection by no means to be considered as contemptible.

The early importance attached to the use of salt has been supposed to be shown by the fact that the Greeks placed this substance in the list of things that were consecrated to the gods; so that it was considered a misfortune to spill salt, and impious to forget to place salt-cellars on the tables, or to go to sleep before their removal. How far this observation may tend to place, so far back as the early Greek period, the use of salt for preserving purposes, I will not pretend to say; but we have direct evidence that amongst the Romans the practice of preservation by salt was general. The Roman sold, as our modern butchers sell now, both fresh and salted meats; their mode of preparing the salted meats being as follows:—The animals they intended to salt were kept from drinking any fluid on the eve of the day on which the killing took place. After the killing, the parts to be preserved were boned and sprinkled lightly with pounded salt. Then, having well dried off all dampness, the operators sprinkled more salt, and placed the pieces so as not to touch each other in vessels which had been used for oil or vinegar. Over the whole they poured sweet wine, covered the contents of the vessel with straw, and when obtainable kept down the temperature of the room in which the vessel was placed by strewing snow round about. This was assumed to make the meat better and more tender. When the cook wanted to extract the salt, he first boiled the meat well in milk, and afterwards in soft or rain water.

In these appliances we discover a degree of art and of skill which shows an advancement even on the proceedings of our own age. When, for instance, the animal was prepared for the process by being deprived of water, an evidence was supplied that the operator knew the fact that animal tissue, recently dead, will absorb a solution of saline matter so much the more promptly if, previously to death, its own water has been reduced in quantity. In boiling the substance that had been preserved by salt in milk, knowledge was supplied of the physical truth that the salt would be given up the more readily to such a fluid as milk than to common water, while, in the final part of the proceeding, the preparation for the table, the use of a water itself unimpregnated with saline particles, and therefore capable of removing the

largest possible amount of the preserving agent, is so admirable, that we may commend it to all English matrons as a wrinkle far to deep to be allowed to pass unforgotten.

There is yet another mode of preserving food, also of ancient date, which consists in securing the exclusion of the preserved substances from the air. Thus Apicius recommends, for the preservation of vegetables, that they should be chosen before they are perfectly ripe, placed in a vessel covered with pitch, and sealed hermetically. In like manner the Roman butchers preserved the flesh of various animals without salt. They hermetically sealed and hung it in a cool place, an operation which was said to succeed well. Apicius also recommends for the preservation of pork a process of a different character. The pieces are directed to be entirely covered with a paste, composed of salt, vinegar, and honey, and to be placed in vessels carefully closed.

The exposure of animal substances to certain gaseous preservatives is a last plan of preservation which also has its origin in a remote period. Common wood-smoke is one of the preservatives which has been thus employed for various animal substances, both in past ages and in modern times. In England, too, a very old custom of preserving fruits, gooseberries especially, has consisted in filling a vessel with the fruit, then burning in the neck of the vessel a piece of sulphur, and corking up securely while yet the sulphur is burning. By this means a quantity of sulphurous acid gas has been generated, and diffused through and detained in the bottle, while at the same time, a portion at least of the free oxygen surrounding the fruit has been removed from the air previously contained in the bottle.

In my next lecture I shall proceed to the description of some original researches in relation to putrefaction and preservation.

MISCELLANEOUS.

THE OPIUM TRADE IN CHINA.

Mr. Nicholson, Secretary of Legation at Pekin, has endeavoured to condense into a small space the information respecting the opium trade of China, which he has been enabled to gather from reports furnished to the Legation by her Majesty's Consulates, and from the Annual Trade Reports of the Imperial Maritime Customs. He observed that of late years the cultivation of native opium has been increasing to such an extent as to afford some ground for the fears which are entertained of the Indian drug being supplanted in the market.

The ports most affected by this new commodity are Newchwang, Tientsin, and Chefoo in the north, and Hankow on the Yanztze, which draw supplies from Central Manchuria, South-Eastern Mongolia, Shensi, Shantung, and Szechuen provinces respectively. Edicts have from time to time been issued prohibiting the cultivation of opium, but they have been in most cases ignored, the only result being an increase in the price of the article, consequent on the necessity of the producer "silencing" the officials. It may safely be assumed that Governmental prohibition does not effect to any degree the cultivation of the poppy. The chief opium-producing provinces are Zunnan, Kweichow, Szechuen, Shensi, Shansi, and also Eastern Mongolia and Manchuria. In all these provinces the cultivation of the poppy has made rapid strides, and the article has, in some parts, improved in quality. The opium smokers in the opium-producing districts are estimated at 5-10ths of the native male population, and the proportion throughout China is computed at 3-10ths of the native male population. Native opium is supposed by the consumers to be less deleterious in its effects than the foreign drug. Some authorities hold, however, a a contrary opinion.

From the statistics it appears that the import of opium into the treaty ports in the year 1876 had been larger than in any previous year, but this was mainly due to the failure of the native poppy crop. With the exception of Szechuen, the chief producing districts suffered severely from the long-continued drought in 1875. The native cultivation has not, as yet, materially affected the supply from India, but authorities on the subject do not doubt that, before long, the effects will become apparent. They also consider that the growth of the native drug may, so far, have only increased the consumption; but, as supply outstrips the newly created demand, it must finally decrease the sale of the imported article, unless the value of the latter is greatly reduced, which can be effected by a reduction of the high duty charged in India. It appears from the statistics that, at some ports, the importation of Indian opium has fallen off considerably; in some, it has received a momentary impulse, owing to local drought; while, in others, it has obtained an immense increase.

The Statistical Secretary, in the Customs Report of 1876, makes the following observations on the cultivation of the poppy:—"In the northern provinces, Shansi, Shensi, and Kansuh, the cultivation of the poppy requires the utmost care on the part of the grower, and the richest soil. It can only be reared with success on the terraced slopes, or on the most fertile bottom land, which allows of thorough irrigation, and which, but for the considerable profits to be derived from the prepared drug, would be devoted to the cultivation of wheat and vegetables. In these provinces, therefore, there is a limit beyond which the poppy cannot be raised with remuneration to the grower, and the production is never likely to be much in excess of the demand for consumption. In the southern and central provinces, on the other hand, the poppy cultivation does not interfere to any considerable extent with that of grain, especially in Szechuen, where the difficulties of transport, in supplying a deficiency in the local crops from the neighbouring provinces, renders necessary the retention of large tracts of land for the raising of grain. The soil here is so rich and fertile that the most suitable ground for the poppy is the terraced hill sides, where the effects of the heavy rains, frequent at certain seasons of the year, and which would render the low-lying fields too damp, are, comparatively speaking, unfelt. Sown during November, it blossoms early in April, and comes to maturity within a month, thus leaving the hills free for a summer crop. Before the poppy has seeded, an intermediate crop of maize, wheat, cotton, or tobacco is grown, the poppy stalks being cleared away in time to prevent interference with the young shoots."

The Commissioner of Customs at Canton states further that much of the land in Szechuen and other opium-producing provinces is owned by capitalists who let it out to tenants at will. The land tax is paid by the landlord, and it is a heavy one, about fourfold what it would be for grain crops, in the case of ground employed for poppy cultivation. The tenants pay no money rent. It is secured to a certain amount in the commencement of the tenancy, and the rent is paid in produce at harvest time. In this way capitalists become large opium holders at times, and even small farmers have a little stock for sale. The yield of opium is very uncertain; bad weather may ruin a whole year's crop, while, on the other hand, one good season may recoup the losses of several bad ones; one mow (say

$\frac{1}{6}$th of an acre) will in a bad year yield 100 taels, value on the spot about 6 taels; in a really good year it would yield about 180 taels, value nearly 11 taels, or at the rate of something under 100 taels per picul. The grower sends his opium to market, where it is purchased by local dealers. These pay several local taxes, market charges, probably many fees, and make a very large profit by selling it, to be carried to Canton or some other port at 12 taels the 100 taels, or something under 200 taels per picul. The duties paid bring this up to 260 taels, and as it sells for more than 200 taels above that sum, there is enough to pay all freight charges and to leave a handsome profit behind. There is a strong pecuniary inducement to grow. As has been shown, about a mow will give on an average 6 taels to 11 taels per annum by opium growing, whereas, if the same land were applied to grain, it would probably yield at most two ton or two ton and a half, worth, say, twice as many dollars.

Mr. Adams reports from Newchwang:—"There can be no doubt that the production of native opium is increasing in this province, and that at no distant day it will form a staple of considerable importance. In the immediate neighbourhood of this post town, and from Naichow all round the coast, it is only grown in inclosed places and for domestic use, not for the market. The soil in that part of the province is stony and unsuitable for the poppy. Even there along the coast where the foreign drug can be obtained without any difficulty from this port or from Chefoo, the native drug is principally consumed, being brought from a place some 300 miles to the north-east in the carts which bring peas and other heavy produce during the winter. The farmer is beginning to regard opium as the first and most important item in the year's crop. This is not surprising, for the poppy crop is a paying one, and it leaves the ground in time for a crop of cabbage and other suitable growth. Still the cultivation has its drawbacks. Drought in spring ruins the crop for that year; the labour is great, and although much can be done by children, it is costly, and in many districts very difficult to procure."

With regard to the prices of native opium as compared with foreign opium, it has been difficult to obtain very reliable statistics. It may, however, be set down that in the producing provinces, the price of native opium is not more than from two-fifths to three-fifths of that of its foreign rival.

THE SUGAR MAPLE.*

Acer saccharinum is a much larger tree than the red maple, and is at once distinguishable from it by the roundness of the notch between the lobes of the leaves. It is one of the largest trees of the genus, often attaining a diameter of from three to four feet, and out-topping the other deciduous trees, sometimes reaching a height of over 100 feet. For fuel and charcoal its wood is especially valuable; it also produces the well-known bird's-eye maple used in cabinet work, supposed by Emerson to be a distinct variety of the sugar maple, but from information given me in Upper Canada, it seems probable that it is only of mere casual occurrence in individual trees. This species is pre-eminently the source of maple sugar, and was known to the Indians before the settlement of the country by Europeans.

I had the advantage of inspecting on the farm of a Dutch gentleman, near Haysville, a section of the forest in which the maples are tapped, and the collected sap boiled down for sugar, the particulars of which I record.

A very interesting physiological point, connected with the production of maple sugar, is the variability of the flow of the sap dependent on diurnal changes of weather, the whole life-force of the big old trees being apparently ruled by trifling changes of temperature and alternations of heat and frost. Changes of life-action occur which are unappreciable to the eye in the daily development of the spring growth, but which the flow of sap records with precision.

The rising of the sweet sap commences immediately after the first break up of the long frost from the middle to the end of February, continuing through March and into the early days of April, but varying in different localities and at different seasons. A cold north-west with frosty nights and sunny days in alternation, tends to incite the flow, which is more abundant in the day than the night. It is, however, most sensitive to unfavourable changes, and from a flow of three gallons a day from one tree may almost cease in a few hours, and then gradually recover itself. From this it will be seen that the flow given from day to day is uncertain, and that reliable statistics of produce are difficult to record. A continuous course of favourable weather tends to the largest production, a rising and falling supply reducing the total produce of the season.

The time at which the flow commences varies, not only with the season, but with the exposure and elevation of the ground, being earliest in warm and low situations. A thawing night is said to promote its flow, and it ceases during a south wind and at the approach of a storm, and so sensitive are the trees to aspect and climatal variations that the flow of sap on the south and east side has been noticed to be earlier than on the north and west side of the same tree.

There are generally from ten to fifteen good "sap-days" in the sap season, which continues on and off for about six weeks, after which, as the foliage develops, the sacharine matter is reduced, and the sap is said to be "sour" though a restricted flow still continues. Emerson, in his work on the "Trees of Massachusetts," referring to Michaux's observations, considers that the product of sugar depends also on the character of the previous summer, and that a season of plentiful rain and sunshine prepares the tree for an abundant harvest of sugar in the succeeding spring. Open winters are thought to cause the sap to be sweetest, and much freezing and thawing to make it most abundant and of the best quality. The sap of isolated trees is richer in sugar than that of those which are massed together in the forest.

In the Maple Bush at Haysville the produce of sugar was at the rate of 1 lb. to each 6 gallons of sap, and the average may be 1 lb. to $4\frac{1}{2}$ or 5 gallons, but Emerson records instances in which 1 lb. of sugar has been produced from 3 gallons of sap. With reference to the produce of individual trees, in a good sap season an average tree will run as much as 3 gallons of sap in a day, occasionally more, and produce about 4 lb. of sugar in the season, but Emerson records instances of the production of 10, 20, 33, and 43 lb. of sugar from single trees. Such weights are, however, altogether exceptional. The highest weight was produced from a draught of 175 gallons of sap from a single tree. The average quantity per tree would be from 12 to 24 gallons in a season.

Young trees under 25 years old are seldom tapped, the smaller trees scarcely paying for the trouble, apart from the debility it produces in the young growing tree. Repeated tapping of the matured trees produces no apparent injury or effect on their vigour. Emerson records instances of trees that have been tapped for 40 consecutive years without injury, and it is said that both the quality and quantity of the sap are visibly improved after the first tapping.

The trees are usually tapped at a height of 3 ft. or 4 ft. from the ground, with a $\frac{3}{4}$-inch auger, to a depth of from 2 in. to 6 in., into which a perforated plug is driven to lead the sap into the collecting vessels, or a simple notch $1\frac{1}{2}$ in. deep is cut with the axe. From one to three taps are inserted in each tree, and these have o be renewed in succeeding years in fresh places,

* George Maw, in the *Gardener's Chronicle.*

generally alternated on opposite sides of the tree. The sap is evaporated either in iron chaldrons or in shallow boilers, 6 ft. long, $2\frac{1}{2}$ ft. wide, and about 8 in. deep. Those of copper are preferred to iron, as they are said to yield a whiter sugar.

Care is taken to keep the boilers filled up with fresh additions of sap during evaporation till the syrup attains a sufficient consistency, which is ascertained by its "breaking" or crystallising when dropped into cold water. The syrup is strained during evaporation, a small quantity of lime or soda added to neutralise any free acids that may be present, and a little white of egg or milk to clear it. After straining and skimming, the syrup is poured into pans or moulds to crystallise, and it may be further clarified by gently boiling in tapering cans with a tap at the bottom towards which the molasses gravitates, and is drawn off as the crystallised sugar sets.

Maple sugar is made not so much as an article of commerce as for the home use of the producers, and the great bulk being consumed where it is made, it is difficult to arrive at anything like an accurate estimate of the total production. Emerson states that in Massachussets alone between 500,000 and 600,000 lb. weight of sugar are annually produced from the maple, and he values it at 8 cents. a lb. In 1874 the price rose to from 10 to 22 cents. a lb. In Canada at the beginning of April last, new maple sugar was selling at from 10 to 11 cents. a lb., about the price of the best cane sugar.

A considerable proportion of the maple sap product is also preserved as syrup without crystallisation, and in this state it is used as sweet sauce and for various culinary purposes.

The maple sugar production is said to be a growing industry, and if the preparation could be centred in well-ordered factories, on the plan of the cheese and butter factories, there is little doubt that carefully-prepared maple sugar would closely compete in price with cane sugar. As it is, with the simple and almost rude appliances for preparation, there is little to choose between the purchase of cane sugar and the cost of producing the local home-made sugar from the sap of the maple.

THE ELECTRIC LIGHT AT SEA.

The following interesting letter, says the *Telegraphic Journal*, has been received by Messrs. Siemens Brothers:—

S.S. *Faraday*, London, August 11th, 1878.

DEAR SIRS,—During our last voyage homeward from New York, we had a proof of the utility of the electric light on board ship.

On the night of the 18th July, near the Georges Bank, we narrowly escaped collision with a large full-rigged ship, under the following circumstances:—

About 10.30 p.m., wind fresh from westward, fog very dense. Suddenly we heard the sound of a bell ringing furiously, at a short distance nearly ahead. We immediately stopped our engines, and supposing it to be a fisherman at anchor, or almost stationary, I ordered the wheel to be ported; at the same moment the electric light pierced the fog, and plainly showed the head sails of a ship heading to the southward, and crossing the bow. Not a moment to be lost, we shifted the wheel to starboard, put the port engines full speed astern, and starboard engines full speed ahead, and cleared her by a few feet only. Our look-out men say they could have stepped on her stern.

She appeared to be full of passengers, and the cries of women and children were heartrending. I never shall forget it. I hailed them several times, telling them they were safe; but it was no easy matter to get them to realise it, seeing death, as it were, staring them in the face.

Of course, they could see nothing but our powerful light, whereas we could plainly see people and everything on board the other ship. Had I not been able to see her so plainly, and the way she was going, we must have gone over her, or she might have struck us on the port bow; in either case the loss of life must have been great, and even now it seems terrible to contemplate.

In this particular case we are more than a thousand times compensated for the trouble and expense in fitting our electric light, and I wish all other steamship owners would adopt it as a means of safety in navigation, for, I believe, when the reflectors are properly adjusted, that the land as well as ships may be seen on a dark night in time to avoid danger.

I am, dear Sirs, yours faithfully,

(Signed) SAM. TROTT.

YORKSHIRE FINE ART AND INDUSTRIAL EXHIBITION.

In the year 1866, an exhibition of art and industry was held in York, under the patronage and support of the nobility and gentry of the county. It was visited by their Royal Highnesses the Prince and Princess of Wales, and by about 380,000 persons. The result of that Exhibition was to leave a handsome surplus in the hands of the committee, and it was resolved that this surplus should be employed in providing some permanent building devoted to the encouragement of art and industry. A site for the purpose has now been secured, and on this it is proposed to erect permanent buildings, specially adapted for the reception and exhibition of paintings and works of art, and also for the accommodation of a technical museum and of the York School of Art, the whole forming the nucleus of a Yorkshire Art Institution.

To inaugurate this scheme, it is proposed to hold a general exhibition, similar in character to that of 1866, for which accommodation is to be provided in buildings erected for the purpose on the site. In order to raise the funds to carry out the object contemplated, a loan fund has been established, consisting of sums of not less than £10, to be advanced as required, for the purchase of site and on account of buildings; the amount so advanced to bear interest at 5 per cent., to be paid off by drawings, dividends, or otherwise out of the profits, as they arise and are available for the purpose. Already upwards of £14,000 has been promised in subscriptions and donations.

The exhibition will be held between the 1st of May and 31st of October, 1879. The following are the divisions under which the exhibits will be classified:—1. Natural products; 2. Manufactures, with a subsection—Art manufactures; 3. Machinery; 4. Applied Science; 5. Educational; 6. Literature and Antiquities; 7. Fine Art. Applications for space should be made at the earliest possible period, to the general secretaries, York, and no application can be received after December 31st, 1878.

CORRESPONDENCE.

EDUCATION IN SMYRNA.

Before entering upon my special subject, which is the important matter of the education of youth, it seems to me necessary, for the sake of elucidation, to preface my paper with a cursory review of the position, extent, and approximate number of the inhabitants of this city.

Statistics have hitherto not been collected in this country, and those which various works of reference have given, have been based on very insufficient data.

Smyrna, the ancient queen of Ionia, and firmly believed by the Smyrniotes themselves to be the birthplace

of Homer, notwithstanding waves of invasion, accompanied by sword, fire, and earthquakes, which she experienced during a long succession of centuries, is even to this very day the emporium of Asia Minor,* and far superior as a seat of culture to any other provincial city in Turkey. Situated in 38°, 25′ N. lat., and 27° 9′ E. long., Smyrna is charmingly clustered round the easterly end of the spacious bay of the same name. Within the last few years it has been adorned with a fine quay of about 2¼ miles in length by 60 feet wide, as well as an extensive port measuring 35,000 square yards, constructed by French contractors. This firm have recently obtained a concession for the construction of an additional basin and an extension of the quay of nearly 400 yards in length.

In computing the number of inhabitants of this city, I shall make use of the most trustworthy data obtainable. According to the latest property registration (*cadastre*) made, the city contains 24,176 numbered doors, comprising the following number of uninhabited premises:—4,285 shops, coffee-houses, and bakehouses; 2,227 warehouses; 515 taverns, drinking shops, casinos, and theatres; 32 public baths; 44 flour mills, comprising steam, water, and horse-power; 52 oil presses, tanneries, and soap factories; and 29 factories, comprising engineers' shops, silk and cotton ginning factories, &c. Deducting these uninhabited premises, there remain 16,992 dwelling places, which, if multiplied by seven inmates of for each, gives a gross total of 118,944 souls for the entire population of Smyrna.

Again, the official data derived from the same source give for the resident Turkish subject male population the following numbers:—Mussulmans, 5,861; Greeks, 6,564; Armenians, 1,814; Jews, 6,902; total, 19,141. Allowing as many again for the female sex we have 38,282; but it must be borne in mind that those figures do not include the foreign subjects,* or the floating Turkish population, which is very large. I have, therefore, compiled the following table, which will show how I venture to arrive at my approximate results:—

Turkish Subjects (both Sexes).				Foreigners (both Sexes).		
Religious Denominations.	Registered residents.	Unregistered or concealed.	Floating population.	Including all Nationalities.	Total.	Observations.
Mussulmans	11,722	1,000	7,278	2,000	22,000	Including garrison, police, custom-house guards, and Persians, and a number of Mussulmans enjoying foreign protection through their being employed at the various Consulates.
Greeks (Orthodox)	13,128	3,000	16,316	23,000	55,444	
Armenians	3,628	1,372	2,000	1,000	8,000	
Roman Catholics and Protestants	....	....	....	14,000	14,000	There are no official data as to the number of Turkish subjects.
Jews	13,804	2,696	1,000	1,000	18,500	
Gipsies	....	....	1,000	......	1,000	Gipsies profess the Mohammedan faith.

Reliable data as to births and deaths are equally difficult to obtain. The sanitary officer is supposed to keep an account of the deaths, but the authorities themselves acknowledge that their statistics are far from being complete. However, they estimate the deaths during the last three years as follows:—In 1875, 2,098; 1876, 2,600; and 1877, 1,812. According to this the average annual death-rate would be, in round numbers, 18 per thousand. In order to check this part of my statistical preface, I have obtained from the Roman Catholic parish register of St. Marie the exact number of births and deaths for 11 years, during which time the population of the said parish was almost stationary at 9,000 souls. The births from 1864 to 1874 inclusive were as follows:—1864—232, 263, 263, 269, 263, 249, 292, 257, 233, 266, and 240; total 2,827. The deaths were in 1864—177, 263,† 187, 186, 196, 159, 183, 192, 146, 185, and 164; total 2,038. According to this calculation the annual increase of population was about 8 per thousand. On the other hand the annual average of deaths for the 11 years was nearly 20 per thousand. Among the various communities the Roman Catholics are the most exact in their registration, nay, the only ones who keep a proper register; it will, therefore, be found that this statement fairly corresponds with that of the health office. My conclusion is that the annual death-rate in Smyrna may be put down at 20 per thousand.

Considering the wretched sanitary state of this city, badly drained with scores of open sewers, the filth and rubbish of the town thrown at random in every open space, and there left to decay, the inhabitants may congratulate themselves upon a climate so beneficent that, with a little care, their city might be made one of the healthiest places in the world.

Having thus far terminated my preliminary description of Smyrna, I now proceed with the statistics I have gathered concerning the special subject of this paper, namely, the state of the popular education in Smyrna, which I am going to divide in two parts, the indigenous or native and foreign education.

Native Popular Education.

Greeks.—An enterprising race, rather intolerant, they are intelligent, and naturally endowed with a quick perception; none of the manifold races inhabiting this empire has more successfully pursued the great object of disseminating gratuitous instruction among their growing generation than the Greeks, particularly during the last quarter of a century.

I.—Gratuitous Instruction.

In 1733, the great philanthropist and benefactor, Pantoléon Sevastopulos, laid the foundation of the "Evangelical School," which he and his co-operators liberally endowed. The founder had the fortunate idea of placing this scholastic establishment under British protection, which it still enjoys. The estab-

* See de Scherzer's work "La Province de Smyrne," published in Vienna, 1873, and containing valuable data about the commerce of this city.

† This was the year when the cholera reigned in Smyrna.

* Foreign subjects consist of two classes, the *bona-fide* foreigners and Levantines; the latter are a compound of different nationalities.

lishment, properly speaking, contains—(1) A fully organised gymnasium (college), with five classes, 229 students being at present enrolled; (2) a preparatory school, consisting of two Hellenist classes, with 174 pupils; and (3) two elementary schools, divided in three sections, each with 338 boys.

The following are the affiliated branch establishments of the "Evangelical School"—1. The Kinpetzoglou School contains one collegiate class, with 24 students; two Hellenist classes, with 89 pupils; and one elementary school, divided in three sections, with 205 boys. 2. St. John Theologos School, elementary, in two sections, with 135 boys. 3. St. John Prodromos School, elementary, in two sections, with 128 boys. Total number of pupils receiving gratuitous instruction, 1,322.

The annual expenses of the "Evangelical School" are between 2,700 and 3,200 Turkish liras.* The revenues amount to about 3,000 Turkish liras, and are derived from rent of warehouses, interest on invested capital, entrance fees from the pupils (scale of entrance fees are—Gymnasium 3, Hellenist classes 1½, elementary ¾, Turkish liras), collections made during the annual feast of the three Hierarchs, Chrysostom, Gregory Theologos and Basilios the Great, annual contribution of the Society "Philomousus," donations and legacies. Children of all creeds and nationalities are admissible into the "Evangelical School," and those not belonging to the orthodox faith are not obliged to assist at prayers, which are only offered in the elementary classes, nor are the non-Christian pupils obliged to attend the lessons of the sacred and ecclesiastical history and Christian morality. During the present year there are 12 non-orthodox pupils frequenting the school, viz., 2 Roman Catholics, 2 Protestants, 4 Mussulmans, and 4 Jews. A very important adjunct was added to the Evangelical School about four years ago in the shape of a public library, which contains already more than 15,000 volumes of different works and manuscripts. The most remarkable among the latter is a well-preserved MS. of the Pentateuch, dating from the 11th century. The formation of a museum of antiquities has also been commenced, and a fair nucleus already exists in the shape of ancient marbles, earth and metal works of art, also a good numismatical collection. Students provided with certificates as having finished their term in the gymnasium are admitted without a further examination into the University of Athens.

St. Dimitris School, elementary, divided in three sections, with 250 boys, supported by "The Brothers of the Cross." The Evanghelistra School, elementary, with two sections, and frequented by 60 boys; supported by the Greek Hospital. St. Nicolas (*salle d'asile*), kept and supported by the St. Nicolas Church, with 100 boys. The Mortakia Elementary School, kept and supported by the church of St. Charalambo, with 60 children. St. Constantine's School, elementary, supported by the wardens of the same church, with 30 boys.

II.—Girls' Schools.

1. St. Photini's School contains four classes of gymnasia, with 95 pupils; five sections of elementary instruction with 396 girls, and two (*salles d'asile*) with 100 children; total, 591; kept and supported by the wardens of St. Photini.

2. The Holy Spirit contains three classes of gymnasia, with 40 pupils; two classes, divided in three sections, elementary instruction, with 250 girls, and one (*salle d'asile*) with 150 children; total, 440; supported by the freemasons of Smyrna.

3. St. Catherine, elementary, with 65 children; supported by the churchwardens of St. Catherine.

4. St. John Prodromos, elementary, with 190 children; supported by the brotherhood of the Annunciation.

5. St. John Theologos, elementary, with 130 children; kept by the brotherhood of St. John Theologos.

6. Mortakia School, elementary, with 94 children; supported by the trustees of the Greek Hospital.

III.—Private Schools for Boys.

1. Commercial School of Nicolas Aronis, founded in 1857, and containing three classes of gymnasia, two Hellenist classes, and three sections of elementary instruction, with 110 pupils, 35 of whom are boarders.

2. The School of the Brothers Gregoriades contains two classes of gymnasia, two Hellenist classes, and three sections of elementary instruction, with 80 pupils, 20 of whom are boarders.

3. The Institute of Smyrna of N. Renièri, founded in 1859 with the object of instructing the Roman Catholic children in Greek, contains 30 pupils.

4. Greek School of Ant. Issigonis, contains two Hellenist classes, and three sections of elementary instruction, with 49 pupils.

5. Greek School of John Boromtzéris, contains two classes of Hellenist studies, and three sections of elementary instruction, with 38 pupils.

6. D. Khariclìés School contains one Hellenist class, two sections elementary instruction, with 30 pupils.

Private Schools for Girls.

1. Charalambo Anastassiades.—One class of gymnasia, three Hellenist classes, and three sections of elementary instruction; 75 pupils.

2. Mrs. Scaramanga's School—One Hellenist studies, and three sections of elementary instruction, with 60 pupils.

3. Mrs. Kydonopoulo's School—Two classes Hellenist studies, and four sections of elementary instruction, with 79 pupils.

4. Mrs. Kokinakhi's School, consisting of three Hellenist classes and two sections of elementary instruction, with 56 pupils.

Miscellanea.

5. Mrs. Chrysanthe Sackelario's School has 150 young boys; the instruction given is according to Mme. Charpentier's system. It is further computed that about 1,500 children of both sexes are taught reading in small day schools. The churches of the adjacent villages, viz., Bournabat, Hadjilar, Bounarbaschi, Cokloudja, Boudja, and Saidikoi support two public schools, one for boys and the other for girls.*

The Greeks have also a communal hospital, and an orphan asylum for girls and boys.

With few exceptions, the instruction given, both in gratuitous (or free) and private schools of this community, is uniform, and the programme of studies is regulated upon that of the gymnasium. Thus, the children finishing a class of studies in any school can enter the class following in a superior one, or the gymnasium.

The following is the curriculum of studies in the "Evangelical School"—1st class of the gymnasium, Greek, Aristides of Plutarch, Anabasis of Xenophon, syntax, repetition of grammar and synthesis, history, ancient history of the East; geography of Asia, Africa, America, and Europe; mathematics, theoretic arithmetic; theology, catechism; French, Abécédaire Chrestomatic de Roux, grammar of Carassontza and method of Ahn; Turkish, reading and writing. 2nd class—Greek, Demosthenes and Plutarch, syntax, synthesis, and themes; history of Greece, by Weber; mathematics, theoretic arithmetic, and chrestomathy, by Deffner; French, chrestomathy of Roux; grammar, of the Carassontza and the Ollendorf method; Turkish, reading and writing. 3rd class—Greek, the Apologies

* A Turkish lira is equivalent to 18s. 4d.

* It is noteworthy that, about 50 years ago, these villages were inhabited almost exclusively by Mussulmans; now it is the reverse, they are almost Christian.

of Socrates, by Plato, Lycurgus; syntax, synthesis, and writing of themes; history of Rome, by Weber; mathematics, algebra and geometry; theology, ecclesiastical history; Latin, Julius Cæsar; French, choice reading and elementary grammar by Lerouse; Turkish, literary selections and grammar. 4th class—Greek, Homer, the Iliad, and 1st and 3rd book of the history of Thucydides; mathematics, 4th and 5th book of geometry, 2nd and 3rd of algebra; physics, general history of the middle ages by Weber, 2nd vol.; philosophy, empirical psychology, synthesis, and writing of themes on the 3rd book of Herodotus; theology, ecclesiastical history, by Diomedes; general history, zoology; Latin, Sallust; French, Manuel de Littérature par Ploetz; and grammar 2nd year by Larousse; Turkish, grammar and syntax. 5th class—Greek, Plato's Menexenus and Sophocles' Antigone; Latin, Virgil Æneid, 2nd book, and 2nd book of the history of Livy; general history of modern times by Weber, 3rd book; mathematics, 6th and 7th book of geometry, and 4th and 6th of algebra; cosmography, experimental physics, synthesis and themes, 2nd book of Thucydides, moral philosophy, and logic by Beck; theology, elucidation of the Bible; anthropology and chemistry; French (the same as in the previous class); Turkish, exercise in commercial correspondence.

A number of Greek children receive instruction in Protestant and Roman Catholic schools as will be seen hereafter.

The Turks.

While the subject races had to provide for their own communal wants, the dominant race, or more properly speaking, the Mussulmans, on account of their general liability to military service, were taught from the earliest times of the conquest to rely upon the provisions made for their welfare by the great and mighty of their creed. Such provision was amply supplied as long as Turkey was ruled by the once powerful feudatory lords, the Derè Beys, &c.

Although that mode of government has been long ago abolished, yet the improvidence to which that system gave birth to still remains innate in the nature of this race; hence the common belief that Turkey is lazy.

The Turks—I am referring to the population of Asia Minor, and in particular the rural—are good-natured, hospitable, honest, and industrious, but I must say, with regret, entirely devoid of any instruction whatsoever; nay even in the very elementary tenets of their creed. If instructed, the Turk has shown himself to be quite as quick and as capable of acquiring knowledge as any of the various races inhabiting this country.

With regard to the non-Mussulmans, it is the community, with the Turk it is either the Government or the municipalities who build their schools and provide for the maintenance of the teachers. Exclusive of the religious establishments, such as *medressés*, day schools, attached to various mosques, where the children are merely taught reading the Koran, the Turkish community of Smyrna has a *Rushdié* school composed of four classes, where an improved system of instruction is given. The programme of studies consist of the Arabic, Persian, and Turkish languages, elementary geography, and history of the Ottoman Empire, arithmetics, ordinary and decimal fractions, geometry, and religion. What renders the task of the Turkish student more difficult than that of the other communities, is the immense loss of time in the studies of those languages which, mixed together, form the Osmanlic literary language, and without which he cannot begin any useful course of scientific studies.

A trades' school, intended for orphan boys, has also been established, of late years, by the Turkish community of this place; it is supported partly by voluntary subscriptions, certain contributions of the Vilayet, and some Government aid. The school is divided into five sections, and the instruction given consists of reading, writing, the first four rules of arithmetic, and religion; the trades are tailors, joiners, and weavers.

Jews.

Until recent years, this numerous, intelligent, and unassuming community, who form almost one-sixth of the entire population of Smyrna, had, to a great extent, neglected the education of their children. Hermetically encircled by their zealot elders, embued with that exclusive spirit so common among Eastern races, their only instruction consisted in Hebrew reading, writing, and the rabbinical interpretation of the Bible. Therefore, unlike their European kinsmen, the Jews of Smyrna have neither turned out to be the princes of finance nor a stirring commercial community. The men are still content with the menial occupation of messengers, hawkers, and petty brokers, a few of them being shopkeepers, while the females of the poorer classes often go as charwomen in Turkish houses, or are employed in the bazaars to clean Vallonea, pack fruits, &c. However, a few years ago, the "Alliance Israélite" of Paris succeeded in creating a nucleus of instruction for the youths by founding a communal school. This establishment has rapidly extended its branches, and it now counts 13 affiliated elementary schools, where the children are prepared for the superior class in the principal establishment. These schools are attended by 1,120 pupils, and are under the direction of 30 teachers.

The programme of studies consist of—(1) Hebrew and and religious instruction, arithmetic, geometry, and algebra; (2) languages, Spanish, French, Greek, and Turkish; (3) geography.

However limited the instruction may be in these schools, still it is undeniable that it is a step in the right direction. I ought not to omit to state that many enlightened Jews send their boys and girls to Christian schools, as will be seen hereafter. In fine, a superior generation is rising up in the Israelite community of Smyrna, destined to promote the well-being of the rest of their co-religionists, which has been hitherto so sadly neglected through want of instruction.*

Armenians.

The Armenian colony of Smyrna contrasts strikingly with the members of the same race still living in their native country, and even with those inhabiting other parts of this empire. Tolerant, active, and enterprising as merchants and dexterous as tradesmen, they have long ago become imbued with the necessity of practical education.

Although the efficiency of their own schools may not be such as those of the European or Greek communities—and the reason of that is that generally those who can afford to send their children of both sexes to European schools do so—still their own communal schools are so far advanced as to give a good practical commercial education. Exclusive of the small day-schools, they possess two national superior schools, one for boys and the other for girls, with 650 pupils of both sexes. The instruction is gratuitous for the poor, while those who can afford to pay do so according to their means. The following is the curriculum of their studies:—Languages, Armenian, French, English, Turkish, and Greek; arithmetic, algebra, and geometry, history, elements of physics, and political economy.

S. Stab,
Cor. Memb. Society of Arts.

Smyrna, 28th August, 1878.

A technical school for girls has been established in Rome, in which lace-making, china painting, designing, and the manufacture of artificial flowers, &c., are taught. The scholars already number upwards of 250.

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* The Jews in Smyrna are the poorest class of its inhabitants.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,350. Vol. XXVI.

FRIDAY, OCTOBER 4, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

DOMESTIC ECONOMY CONGRESS.

The Report of the Congress on Domestic Economy, held at Manchester in June last, has been published, and can be obtained at the Society's House, price 2s. 6d., bound in cloth.

The Report contains the Papers read at the Congress, with the Discussion thereon, the Rules and Regulations of the Congress, &c.

For the convenience of those who have already purchased the Pamphlet containing the Papers, which was issued at the time of the Congress, the part of the Report containing the Discussion, Rules, and Regulations, &c., has been issued separately, price 1s., in paper wrapper.

The Reports of the Birmingham Congress in 1877, and of the Manchester Congress in 1878, can be obtained, bound together, price 3s. 6d.

NATIONAL WATER SUPPLY.
HEALTH AND SEWAGE OF TOWNS.

The Reports of the Congresses on the above subjects have been published in pamphlet form, and each report can be obtained at the Society's House, price 2s.

The Council of the Society of Arts are endeavouring to prepare a complete list of all the Reports of Medical Officers of Health which contain references to water supply. They will be much obliged if Medical Officers will communicate the dates of such reports, and, if convenient, send copies to be preserved in the library.

PROGRAMME OF EXAMINATIONS FOR 1879.

The Programme for 1879 is ready, and can be had on application to the Secretary. The Society's Examinations now comprise the following divisions.

1. Commercial Knowledge.
2. Domestic Economy.
3. Fine Arts applied to Industry.
4. Music.
5. Technology of Arts and Manufactures.
6. Elementary

A Pamphlet containing Specimen Examination Papers in most of the subjects is published, and may be inspected by intending Candidates in the Libraries of the Institutions in Union with the Society; or copies may be had on application to the Secretary of the Society of Arts, price 6d.

NATIONAL TRAINING SCHOOL FOR MUSIC.

A competition for the vacant scholarship of the Society of Arts was held at the National Training School for Music, on Monday, the 30th September last. The Examiners were Arthur Sullivan, Esq., Principal, and Ernst Pauer, Esq., of the Board of Principal Professors. There were twelve candidates, of ages varying from 12 to 19 years. The scholarship was awarded to Mr. Ernest Crook, violinist, aged 14 years.

The Examiners regret that there were no scholarships to award to Miss Sandwith, Miss Bigwood, and Miss Tacagni (violinists), and Miss Wood (pianiste), who are commended for their talents and acquirements.

In accordance with the announcement previously made, preference was given to a violinist in the award.

CANTOR LECTURES.

SOME ORIGINAL RESEARCHES ON PUTREFACTIVE CHANGES AND ON THE PRESERVATION OF ANIMAL SUBSTANCES.

By Benjamin Ward Richardson, M.D., LL.D., F.R.S.

Lecture II.—Delivered April 15th, 1878.

In my last lecture I treated on the past history of preservation, as that has been written in the practical processes of embalming, preserving specimens for the museum, and preservation of foods. I showed in that lecture that in the development of these processes certain princples had been arrived at, to which little has been added in modern times except in matters of detail. These principles included the methods of preservation by the use of antiseptics, drying or desiccation, removal from the influence of common air, and the application of cold.

I proceed in the present lecture to the task of placing before you some researches, which I have conducted on my own part, in relation to the subject of preservation. The researches commenced as far back as the year 1850, and they may be divided into four series. A first series, extending from 1850 to 1862-63; a second, from 1863 to 1871; a third, from 1873 to 1874-5; and a fourth from 1877 to 1878, which latter has been conducted, chiefly, with reference to this present course. I name these series because in each stage of research some different mode of work, depending on a different line of suggestion, derived from experiment, has been followed.

The first line of experimental work was carried on under the impression that all putrefactive changes are due to the direct action of atmospheric

air on the substance that is undergoing decomposition, or putrefaction. Putrefaction was thought to be a process of oxidation, somewhat like the rusting, or oxidation, of iron in one sense, but differing in that, owing to the complex composition of the substance oxidised, new products are evolved, through which evolution the substance is broken up, or resolved, into gaseous, or vaporous, forms of matter. Liebig described the process of slow oxidation of some organic things, and called the process "eremacausis," a slow combustion from oxidation, partaking of the nature of a fermentation. This theory of the process of decay was applied to explain the decomposition of most organic substances, and the decomposition of the dead flesh of animal bodies especially. It was, therefore, natural to suppose that, if this process of oxidation from without could be checked, or suspended, the preservation of the animal substance would thereby be secured. At the time to which I now refer, 1850, this was a commonly accepted belief.

My work, therefore, in my first series of researches, consisted in trying to find out some plan by which the oxidation could be arrested, and it embraced two forms of research. 1. To ascertain if mere immersion of the organic dead substance, while it is yet fresh, in a purely negative gas, would prevent the change. 2. To ascertain if the presence of some other gases, or vapours, which are not to be considered as purely negative, would prevent the change.

Action of Negative Gases.

The first inquiry I made was carried out with negative gases. It occurred to me that, if a portion of organic animal substance, dead but quite fresh, were immersed in an atmosphere of a pure negative gas, the process of decomposition ought to be assisted. In this research a bottle was used which had for its stopper this sliding tube of metal. The tube fits into the neck of the bottle like a cork, and is firmly set. Within the outer tube is an inner one which is closed at the bottom, but is open on one side, and which, being smaller than the outer tube, can be pushed into the bottle until the side opening is exposed in the bottle. The inner tube can be closed by a stopper at its outer opening. When this bottle is used the metal tubular stopper is firmly inserted in the neck of the bottle, and the inner tube is pushed down to make a connection with the inside of the bottle, and through it the bottle is completely filled with the gas that is to be used, by displacement of its contained air. The inner tube is then drawn up to effect closure, and the bottle is ready charged. It remains now to introduce into the bottle the specimen it is wished to preserve. The specimen is placed in the inner tube and the tube is inserted under water, or mercury, or oil, on the shelf of a small pneumatic trough. The tube is then filled with the same gas as is in the bottle, and when the filling is quite perfect the tube is stoppered under the fluid in which it is immersed. The bottle is now placed upright, and the inner tube being pushed down into the bottle, the specimen drops into the bottle, through the opening in the side of the inner tube, and is left exposed to no other substance but the contained gas or vapour, the preserving process of which is under observation.

Nitrogen Gas.—I commenced my experiments with nitrogen. The bottle named above, first carefully filled with pure nitrogen, was made to receive the portion of animal substance that was to be subjected to experiment. As a rule, this consisted of beef, the fleshy part of beef, divested as far as possible of fat. When the flesh was immersed in the new atmosphere, and thoroughly closed in the containing bottle, the bottle was placed in a testing chamber, which consisted of a closed safe, the air of which was steadily kept at summer heat. Side by side with this specimen, a similar portion of beef was kept in another bottle, equally well closed, but filled with common air; another specimen was also kept in another similar bottle, which was filled with air, and was left open to the air, the stopper being removed.

The results obtained by these experiments with nitrogen were negative, in so far as a preservative effect is concerned. The nitrogen was found not to be a preservative. The animal substances placed in it were not preserved longer or better than were those placed in air sealed up in the air bottle. Both were longer and better preserved than in the test specimen that was exposed to the air. In forty-eight hours all were tainted, but the specimens exposed to the air in the open bottle were, as a rule, tainted in a third of that time. The colour of the specimen closed in nitrogen differed from the colour of the specimen closed in air. It assumed very quickly a greyish-green tint, while the specimen in air retained its red colour, or changed merely to a dark red, until complete decomposition set in; then both specimens became very dark.

Hydrogen.—The same line of experiment was pursued with hydrogen gas, and with the same negative results in relation to preservation. In hydrogen, the specimen became rapidly dark, and very soft and spongy in its texture.

Arseniuretted Hydrogen.—Arseniuretted hydrogen preserved specimens in a most effective manner, but in it the natural colour of the flesh was not retained. The flesh assumed a greyish colour, much like to that which occurred in nitrogen. How perfect the preservation was may be inferred from the fact that here is a specimen of a small heart, the heart of a rabbit, that has been preserved in this gas since the year 1850. The structure and form is perfect to this hour, and the preservation of structure is seemingly perfect. You will see, however, that the colour is an unnatural grey, and so it has been from two days after the time when it was sealed up in the gas.

The experiments with arseniuretted hydrogen were not pursued because of the poisonous nature of the gas. I thought at first that pathological specimens, structures showing disease, might be preserved in it, and I exhibited some examples of this plan of preserving to the Medical Society of London. The danger of manipulating the gas, and the danger of its escape from the bottles, led me, however, to abandon its employment.

Oxygen.—It had been shown, before my research commenced, that if a stick of phosphorus, from which the external coating of oxide had been thoroughly removed, were placed in dry pure oxygen, the oxidation of the bright surface of the phosphorus would not occur unless some motion were supplied, or some diluting gas, like nitrogen, were let in to commingle with the oxygen. The late Dr. Snow,

in his essay on continuous molecular changes, made much of this experiment in illustration of his views as to the molecular forms of attraction, and the conditions by which such attraction is developed. I repeated the experiment with phosphorus, and finding the oxidation in oxygen was suspended even at a considerable elevation of temperature, it occurred to me that perhaps the same suspension of oxidation would happen if animal substances were enclosed in pure oxygen. I therefore proceeded to place specimens in pure oxygen, as I had already placed them in nitrogen and hydrogen, and with the same methods of testing for results. The results were very interesting. At summer heat, the animal structure underwent change in oxygen in the same manner as in common air in the closed bottle, but in both slower than was the case in specimens exposed openly to the air. At lower temperatures, at 50° F., the specimens enclosed in oxygen were better and longer preserved than were similar specimens enclosed in common air. In all cases the specimens of red flesh in oxygen were remarkable for the perfection of colour which remained in them. When they were fœtid they still retained their bright red colour. I shall show, before this course of lectures is completed, that this effect of oxygen in relation to colour may be usefully applied. Altogether oxygen, as a distinct preservative, was found at ordinary pressures to be a failure: it preserved colour, but not structure.

Coal Gas.—From oxygen I passed to coal gas, and from the researches made with that gas obtained a large number of curious facts. The same simple plan of experiment was followed out, and the same comparisons were instituted. To my surprise I found that, at summer heat, coal gas showed a most decided preservative quality; specimens were kept in it for six days free from any decomposition, after specimens sealed up in common air had become tainted. What was most surprising of all was that the colour of red specimens was perfectly retained, or was even heightened by the immersion in the gas. It has since been made clear, from numerous experiments by different observers, that carbonic oxide has the property of sustaining the colour of blood, and of tissues coloured by the blood; and the reason why coal gas acts in retaining the colour of the specimen is, that it contains invariably carbonic oxide as one of its parts. In most of my experiments since the first observations on coal gas, I have employed it largely as a menstruum for conveying other gases or vapours, in consequence of the preservation of colour which it maintains, as well as on account of the readiness which which it is at command. In many specimens which are on the table before you, you will find the preservation is perfect, and the colour as fresh as if the structures, which have been enclosed many weeks, had been removed immediately from the dead carcase, and in all these coal gas is the menstruum. Beyond this action of the gas the preserving power is comparatively low. Such power as it possesses for preserving structure depends on the ammonia and on the sulphur gases it contains, and these are not present in sufficient quantities to produce a prolonged effect of preservation.

Chlorine.—Chlorine gas was tested in a few experiments rather as a matter of curiosity than from any expectation of obtaining a practical preservation. The gas was found to preserve structure by rendering the mass hard, but the colour was entirely and rapidly changed from red to grey and from grey to white. There is a good specimen here showing the action of chlorine. I noticed in these experiments with chlorine that when the specimens were removed from the bottle, after the entire absorption of the chlorine, some singular volatile organic compounds were found. I have never had time to follow up the inquiry as to the nature of these products, but it opens up a good field for some young chemist who may want a new subject in organic chemistry for his investigation, and, therefore, I name it. As a practical preservative, chlorine must be set aside.

Sulphurous Acid.—The ancient housewife experiment of burning sulphur in a bottle, and then dropping gooseberries, or other fruits, into the bottle, in order that the fruits may be preserved, led me, naturally enough, to test the action of sulphurous acid as a preservative of dead animal structure. I thought the same experiment had been made before, but on that point I could not assure myself, since I failed to find any reference to it in the works of preceding authors. The method I pursued was the same as in the other experiments with the gases which have been already referred to. The result was to find in sulphurous acid a perfect preservative of structure, but with the important disadvantage that the natural colour of the flesh is entirely destroyed by it. The flesh is bleached as effectually as by chlorine, and, although it is not made so dense and firm in character as it is under chlorine, it is somewhat condensed. A specimen of muscle of beef preserved in sulphurous acid is here at hand. It was placed in the gas six weeks ago, and it is as free as at first from all taint. It is nearly white, and could not be told as beefsteak; and it is rather too firm in texture. But it is quite wholesome, and might be eaten as food, after cooking, without any danger. When it is cooked, the taste of it is not unpleasant, the only difference in it from fresh meat being a slight acidity, which, though so slight it is all but imperceptible, is just sufficient to take away the usual flavour of fresh food. In the preservation of colourless animal foods, such as common fowls and white fish, sulphurous acid could be extensively employed, as I shall show in a later lecture, by a very simple process of application. For red meats the gas is, by itself, not so applicable, because of the bleaching which it causes.

Antiseptic Vapours.

Chloroform.—Proceeding on the theory or hypothesis of the cause of putrefaction, that the process of putrefactive change is a direct oxidation, and that the change could be arrested by any harmless plan that would arrest oxidation, I had recourse to some vapours of volatile fluids, in order to discover an effective agent. The first of these vapours was the vapour of chloroform.

I was led to chloroform in the first instance by the following experiment, which was introduced by Dr. John Snow for the purpose of illustrating, as he thought, the action of chloroform vapour in producing anæsthesia or insensibility in living animals. The experiment is as follows, and as I now perform it.

You take two glass globes of equal size, each

well dried, and each fitted with a nicely fitting two-inch stopper. Into one of these you introduce a little fluid chloroform, one fluid drachm in a globe of 100 cubic inch capacity. When the chloroform is introduced, you place the stopper into the globe and gently apply heat to the globe externally, moving it at the same time, and permitting the stopper to rise a little, with the expansion of the vapour. When the chloroform is all diffused into vapour in the globe, you set the globe side by side with the other globe that contains air. Then you remove the stopper of the globe that contains air, and insert into it a lighted taper. The taper continues to burn. Next you transfer the lighted taper from the globe that contains air simply, into the globe that contains air charged with the vapour of chloroform. As this is done, the light, as you observe, is immediately put out. The vapour of chloroform, by its pressure, prevents oxidation, and therewith the combustion. Snow held that when the vapour of chloroform is inhaled by the living animal, the vapour dissolved by the blood in the lungs, and carried by the blood into the body, is capable of arresting the oxidation of the tissues everywhere, of interfering by this means, for a time, with nervous function, and so of preventing sensibility and conscious life.

If chloroform has this power of preventing the combination of oxygen with living organic matter, it ought, I reasoned, to have the power also of preventing the changes of resolution in dead organic matter. It was as to its power in this respect that I put the question to nature.

In the experimental method, the same apparatus was used as before. Instead, however, of charging the preserving bottle with gas to the entire exclusion of air, I diffused the vapour through air in the bottle, exactly as I have diffused it in the globe, in the experiment with the taper. In other respects the experiments were tested as in the researches which had been made with the gases.

The results of these inquiries were of a striking character. The vapour of chloroform was found to be strongly antiseptic. For a period of three weeks, when the stopper of the containing jar was well secured, the portions of flesh were kept free of taint in the vapour of chloroform. At the same time there was again a drawback in respect to colour. The vapour of chloroform caused destruction of colour, rendering red structures of whitish grey hue. There is in a jar here a specimen of beef that has been preserved in vapour of chloroform for fifteen days. If it be removed from the jar it will be found fresh, in structure, and when the vapour of chloroform has evaporated, not in any way peculiar to the taste; but the colour, so changed and dirty looking, is unfavourable; and, after all, the preservation of structure is not satisfactory. The preservation is limited in its duration, for in time the texture becomes softened, and, though not fœtid, disagreably acid and musty.

Chloroform and Coal Gas.—In another set of experiments I combined the vapour of chloroform with coal gas, diffusing the vapour through the gas as I had previously diffused it through air, and then inserting the structure in the mixture and sealing it up in the bottle. By this means I succeeded in preserving structure as well as colour. There is a specimen at hand preserved in this manner which I will now send round. The preservation has been maintained for four weeks at the ordinary temperature, and I do not think you would readily detect the difference between it and a piece of beef that has been kept in the air for twelve hours. The specimen could be cooked and taken as food. The objection to it as food would be a taste and odour, derived from the coal gas, which are objectionable, and which prevent, to a large extent, the perfect utilisation of the gas for preservation. Further, the preservation of the specimen, though so good so far, is not sufficiently good. In time the same changes, less the change of colour, that would take place in the mixture of chloroform and air, would take place also in the mixture of chloroform and coal gas. The specimen would become soft, and would emit an acid, musty odour. Taking it altogether, we may place the vapour of chloroform amongst antiseptics that deserve to be remembered, while we give to it a third or fourth rate place in value as an antiseptic.

Vapour of Ether.—In connection with the experiments with vapour of chloroform, I carried out another series with the vapour of the ethylic ether. In no particular was the form of experiment varied, except that vapour of ether replaced vapour of chloroform. The results were different. The ether vapour caused rapid discoloration of the specimen, which discoloration was not altogether corrected by the presence of coal gas; and the structure, although it did not decompose in the ordinary sense of the term, was rendered soft in texture and of acid smell. The action of ether is well illustrated in a specimen, now to be sent round, which has been in an atmosphere of common air saturated with the vapour of ether for a period of 15 days. The flesh is not fœtid, but it is so changed it could not be made of any service for food purposes.

Bisulphide of Carbon.—In his experiments with anæsthetic vapours, Harold Thanlow discovered, in 1848, that the vapour of bisulphide of carbon could be used for the purpose of producing insensibility to pain, and that the narcotism caused by its inhalation was as deep and as safe as that caused by chloroform. This observation led me to test the action of the same vapour in regard to its antiseptic value. I need not trouble you with the procedures, because they were repetitions of the same procedures as were employed with chloroform and ether vapours, but I am bound to report that the results were much more determinate. The preservative action of the vapour of the bisulphide of carbon on the structure of the specimen was exceedingly perfect and prolonged, when the bottle was kept securely closed. Two objections attend the employment of the bisulphide vapour. One is the difficulty of retaining it in the closed vessel when there is elevation of temperature to summer heat; the other is the determinate bleaching action of the vapour on the colouring matter of red flesh. The bleaching is preventible by the plan of diffusing the vapour through an atmosphere of coal gas; but the difficulty of escape of the vapour is not so easily managed. It might be supposed that a vapour so exceedingly offensive to the smell as the vapour of the bisulphide of carbon is, would give an odour and taste to the flesh immersed in it which would render the flesh positively intolerable

to smell and to taste. This, however, is not the practical fact. The preserved flesh, when it has been hung up in the air for an hour or two after removal from the preserving jar, is free of taste and odour, except perhaps a slight bitterness of taste. You can judge of the power of the preservative from two specimens before you. They have been preserved in common air charged with the vapour, the one fifteen days, the other forty-five, and they are in every respect free of putrefaction. The bleaching they have undergone is the objection to the plan by which they have been so long preserved, and that is met, as another specimen shows, by using an atmosphere of coal gas, as the menstruum for the vapour, instead of common air.

I have now presented a *résumé* of my earliest researches on the antiseptic properties of gases and vapours. I daresay the research was very imperfect, but, as far as it went, it was faithful and efficient. It brought out several new facts, and if it did not sustain the theory on which it was based, and I am bound to say it did not altogether, it made the further progress of work more easy and comprehensible.

The facts which the investigation brought to light were chiefly as follows:—First, it was made clearly obvious that the hypothesis which had been put forward to explain the cause of putrefactive change, and on which the research was based, viz., that putrefaction is an immediate process of oxidation from contact of dead organic matter with the atmospheric oxygen, would not hold good. It was proved in many cases that putrefactive changes progressed in atmospheres from which oxygen had been entirely excluded, in which there was no free oxygen at all, and in which there was not even oxygen in combination. These facts did not, it must be observed, destroy the correctness of the view that the process of putrefaction is a process of oxidation; but they showed that the oxidation was not owing, directly, to contact with the oxygen of the air. A second fact taught by the research was, that in considering preservation of flesh that is coloured, two distinct problems have to be borne in mind—the preservation of the structure, and the preservation of the colouring matter. To illustrate what I mean by this, I should inform those who have not studied the subject that the red matter which gives the colour to the flesh is a distinct colouring substance derived from the blood, and called hæmoglobin. This is diffused through the structure of the flesh, but is so distinct from it that it can be washed out, leaving the structure of pure whiteness. I have taken here a firm clot of blood, and by subjecting it some hours to a stream of fresh water on a fine sieve, have washed out all the colouring stuff, and have left behind this specimen of pure white, fleshy, fibrous substance which is called fibrine, and which is, indeed, the basis of muscular flesh. I have taken in another experiment a large piece of muscle from the ox, a beef steak, and have subjected it to a similar process, placing it for some hours in a current of water, and having it repeatedly pressed and wrung out. By this means I have here again removed all the colouring matter, and have secured a portion of flesh so white you would never suppose it was taken from the carcase of an animal that has coloured muscular fibre. These experiments have been done to show the two bodies which in red flesh have to be preserved, for they are preserved in their freshness by very different processes.

It is a curious problem why, in some animals, the colouring matter gives colour to the flesh, and why in others it does not give colour. The blood of the rabbit and of the hare is the same, as far as we know, but the colouring principle of the rabbit does not diffuse into the muscular fluid, so the flesh of the animal is white. The colouring matter of the blood of the hare does diffuse, so the flesh of the animal is red. I might extend these comparisons. I might compare the salmon with the codfish, the barn-door fowl with the red grouse, and so on, but these contrasts will all occur to you. The singular question is, why in one case the diffusion should take place, and not in all cases? I have made many attempts to solve this difficulty, but have not succeeded in solving it.

To return, we have to remember the two preservations in the case of all coloured animal foods; we have further to remember that substances which will preserve the colour will not necessarily preserve the structure; and, again, that substances which preserve the structure will not necessarily preserve the colour, but may, in fact, destroy the colour.

To take examples from the specimens which are on the table. In this closed jar there is a portion of beef so red and fresh looking it would seem to have been just taken from the carcase of the animal that supplied it, and have been put into the jar. You would find out your mistake if you were to open the jar, for the specimen is completely decomposed, and is most offensive to the sense of smell. In another jar which I send round, is a specimen of beef from the same carcase which is almost as white as the flesh of a fowl, but it is not decomposed, nothing more has happened to it than that its colouring stuff has been bleached by the gas that has preserved it.

Another fact gained from the research has relation to the odour of the substance preserved. The odour indicative of putrefactive change excludes, of course, all idea of success in every experiment, but it was found that there were other odours which were objectionable, even when fair preservation was effected. The odours so evolved were those of acidity, or of mustiness, or of taints or scents like those of some flowers or leaves. In some instances the odour of the substance itself was unobjectionable, but that of the preservative was too perceptible. In these last-named cases the preservative remained fixed in the specimen, and was itself a cause of failure.

A fourth fact was learned in respect to the chemical reactions of animal substances undergoing experiment for the purpose of preservation. The colour might be retained, and the odour might not be offensive, but from the reaction it was detected that the process of decomposition had commenced. Flesh which is alive in the body of the animal has, I find, a neutral reaction; it is neither acid nor alkaline; but after an animal is killed, and the flesh is exposed to the air, there is quickly set up an acid reaction which lasts as long as the dead structure remains what is called "fresh." As the structure begins to change, the acid reaction becomes neutral, and from that it soon passes to

become alkaline, whereupon it may may be considered to be putrefying. With some apparent preservatives the alkaline change is set up even in their presence, and when that is the case the action of the agent may be considered at an end, since an alkaline food is, as a rule, objectionable both to taste and digestion.

Among other and further facts that were taught by the research, were some that related to the consistency of the structure, the escape of water from it, and the minute changes of structure which were observable in it by the microscope. Touching these, I may say that in some specimens the consistency is so much modified from the natural that this change alone negatives the value of the preservative. The structure may be soft, almost pulpy; it may be spongy, from infiltration with gas; it may be condensed and firm; it may retain all its original water, or it may give up so much water as to be enclosed partly in its own water coloured with the colouring matter of the blood. You will find illustrations of all these changes in the specimens that are on the table.

The most striking changes of all observed in these first researches are some structural modifications or degenerations of tissue which take place in some of the gases. These are of two kinds at least, fatty and gelatinous. From the fatty change the muscular substance is changed altogether into a waxy or fatty state, so that every trace of the original muscular fibre is lost. From the gelatinous change, the muscular structure passes into a resemblance of gelatine, and presents many of the peculiarities belonging physically to true gelatinous substance. You will find two fine examples of these changes amongst the specimens.

It will be gathered, from what has been said, that the process of perfect preservation of animal substance is a more difficult discovery than it might at first sight appear to be. There is, it will be observed, a series of different questions involved in the solution of the difficulty. You may preserve to the sight, but not to the smell; to the touch, but not to the taste. You may prevent decomposition in the ordinary sense of that term, and in so doing, you may set up a kind of degeneration which is destructive of the original character of the substance. To make these matters definite, to show what has to be done in the art of preservation, I have placed the leading facts in the following tabular form:—

PRESERVATION.

For perfect preservation of animal substances, it is necessary to retain:—

(a) The natural colour.
(b) The natural odour.
(c) The natural reaction.
(d) The natural water.
(e) The natural consistency.
(f) The natural microscopical appearance.
(g) And, if the substance be for food:—The continuance of natural colour and odour after removal from the preservative (in comparison with a fresh specimen), the natural odour during cooking, and the natural taste and flavour after cooking.

It is necessary to avoid—

(a) Odour of putrefaction.
(b) Odour of other taints.
(c) Odour of preservative.
(d) Fixation of preservative.
(e) Escape of water.
(f) Gaseous infiltration.
(g) Fatty change (in muscular substance).
(h) Gelatinous change ,,
(i) Acid fermentation.
(j) Alkaline reaction.

A little time after making the observations on the effects of gases and vapours that are above recorded, I came upon the fact that the vapour of ammonia is one of the most powerful of antiseptics. In observing the action of ozone on ozone test paper, I noticed that the action of ozone, in oxidising, is interfered with by the presence of ammonia. This led me to place dead animal structures in the vapour of ammonia, and to preserve them for any time without the occurrence of putrefaction. The observation led me further to suspect that gases which preserve act after the manner of salts, and that the origin of putrefactive decomposition begins in decomposition of the water of the tissues. I will follow up this point when we next meet.

MISCELLANEOUS.

PATENT-OFFICE REPORT.

The annual Report of the Commissioners of Patents for 1877 has just been issued. It commences with statistics of the number of applications for, and grants of, Letters Patent during the past and preceding years. The first fact mentioned is the somewhat unsatisfactory one that the number of applications for patents, for the first time since 1870, shows a decrease as compared with the number of the year preceding, there being 4,949 in 1877, as against 5,069 in 1876. The ebb and flow of inventive genius in this country is strikingly shown in a chart appended to the report, which gives the increase and decrease of the numbers of patents applied for and in force at the end of three, seven, and fourteen years respectively, for each year from 1852 (the year in which our present Patent-law came into force) to 1877. An examination of this chart shows a remarkable constancy in the relations between the number of applications and the number of patents lasting for the specified periods during the past twenty-five years. The chart is divided horizontally into year spaces, and vertically into spaces numbered from 500 to 5,500. The line of applications shoots rapidly upward in 1853 under the influence of the new Patent-law from 1,211 to 3,045, and the other lines approximately correspond, rising from 891 to 2,113, from 310 to 621, and from 102 to 205. The year 1853, however, was an exceptional one. Our notice, therefore, of the comparative numbers may commence with the end of 1853. Taking first the line denoting applications, this dips slightly (2,764) in 1854, and then rises steadily till 1857 (3,200); then falls in 1858 (3,007), and remains stationary for a year (3,000). Next, it rises till 1862 (3,490), falls for two years (3,260 in 1864), and rises till 1868 (3,991); then again comes a drop for two years (3,405 in 1870), and then a long rise, culminating in 1876 with 5,069. The line representing patents in force at the end of the third year—*i.e.*, completed patents—follows tolerably closely the shape of the

first mentioned one, the rough proportion throughout being about two completed patents to three applications. The character of the third line, which shows the number of patents in force to the seventh year, or the number on which the renewal fee was paid at the end of the third, is of an apparently different character. It rises and falls at the same periods as the former lines, but it deals with smaller numbers and, therefore, its fluctuations do not so readily catch the eye. The numbers in this case vary from 621 in 1853, to 953 in 1874, the last year for which data can be given for this class. The actual lowest number of patents renewed after the third year was 513 in 1854. The proportion of these renewals to original completed patents is about three to ten over the whole period, and this is fairly constant for single years. The lowest line of all, representing patents renewed at the seventh and in force to the fourteenth year, deals with numbers varying from 205 in 1853 to 280 in 1870 (the last year for which figures are available), the highest and lowest figures being 309 and 140. The proportion of these survivals is one to ten of original completed patents. It is a striking fact, and one which has been frequently commented on, that only some 300 patents a year are worth £100 at the end of seven years' trial.

The next part of the Report containing any matter of novelty refers to the special indexing department recently established at the Patent-office. Those who are familiar with the publications of the Patent-office know how needful it has become to amalgamate the yearly volumes of indexes which have accumulated since 1852. The necessity of consulting so many separate volumes in searching for any special invention has greatly increased the labour of such tasks, and, doubtless, patent agents and inventors will be pleased to hear that the reform is about to be undertaken. A new index for the "Old Law" specifications is also in course of preparation, and will replace the present imperfect one, which was prepared, before the printing of the specifications, from the titles only. The Report says that "the subject-matter indexes under the new law to 1873 inclusive, were not prepared according to the comprehensive plan adopted with this kind of index for 1874 and subsequent years, and consequently need revision." It may perhaps be questioned whether this rather severe criticism by the Commissioners upon their own work will be endorsed by all who have to use the indexes, except in so far as it applies to two unlucky years—1871 and 1872—when there was a sort of interregnum between the old style and the new. For this indexing department a special staff has been provided, and they have already commenced their work.

The notice about the classified abridgments gives a little more information than was contained in previous reports, as to the scope of these publications, but, in the main, is much the same as last year, except that the list of classes already published is extended. The principal additions consist of second parts to many of the classes already published, bringing the abridgments down to 1876. The original scheme for these abridgments stopped short at 1866, and the intention was that the abridgments after that date supplied by the inventor were to be classified. After some years' trial these original abridgments were found unsatisfactory, and it was decided to continue the system of official abridgments. In all 91 series have now been issued, and of these four have been continued down to 1876. These are "Bleaching," &c., "Photography," "Agriculture," and "Chains and chain cables." Though no others are announced in the report, it is understood that several more volumes are almost ready for publication. There have been frequent demands for this continuation of the work, and a fruitful source of complaint has now been abolished. It is obvious that the more recent inventions, those of the last ten years, are likely to be of more importance to new inventors than those of older date; and, doubtless, this fresh aid to those who have to study the course of modern invention will be duly appreciated.

A short note refers to the new sale department, which, it may be worth noting, has been lately re-organised and transferred to the building in Cursitor-street formerly occupied solely by the store department. In consequence of this extension, it has been placed under the charge of a first-class clerk.

On the subject of the Patent-office Museum, there is nothing new. 262,909 persons visited it in the year, the total of visitors since the opening in 1857 being over 4,207,000.

A new rule to provide for the correction of clerical errors in certificates of registration of designs was made in 1877. Beyond this no change worth mention seems to have occurred in that department of the office.

On the subject of trade marks the Report says:—

"The number of applications for the registration of trade marks during the year 1877 was considerably less than during the first year of the establishment of the Trade Marks Registry, but the experience which had been acquired during the year 1876 enabled greater progress to be made in the final stage of the work, and consequently a much larger number of marks were placed upon the register in the year.

"The operation of the Act being to collect for the first time the vast number of trade marks in use in the leading branches of trade in the United Kingdom, brought to light an extensive usage, in some branches of trade, of open or common marks.

"So extensive was the use of these marks found to be in the cotton trade that, as reported last year, special provision had to be made for separately dealing with these marks at Manchester.

"The settlement of questions connected with the applications for the registration for common marks in the various trades, as well as the decisions upon different points of law sought for in the High Court of Chancery, have been productive of some delay in registering certain classes of marks.

"Since the date of the last report, the Committee of Experts at Manchester have been engaged upon the examination of the 41,712 marks applied for in Class 24, viz., for cotton piece goods. In consequence of an appeal to the High Court of Chancery against one of their decisions relative to combination marks, the committee were unable to complete the examination of the old marks applied for in Class 24 by the 30th June, 1878, and an extension of time to 31st December following was, therefore, provided for by an Order in Council for the completion of the work.

"The total number of marks dealt with by the committee up to the 30th June last was 33,681, leaving 8,031 to be examined."

The report also gives a classified table, showing the numbers of trade marks registered, &c., in the different classes.

The receipts of the office from all sources were £183,720, as against £185,371 in the year 1876; the patent fees being £168,197, as against £169,992. The remainder is made up of fees for designs and trade marks, sales, &c. The surplus income this year is both actually and proportionately less, being £138,523, whereas it was last year £139,067. The ever-increasing surplus since October, 1852, now amounts to £1,607,362 earned by the Patent-office—a million and a half in twenty-five years.

The principal charges of outlay are salaries, £23,973, and printing, £13,316, which is a reduction of nearly £1,700 on the previous year's bill of £14,996. This saving, it is to be presumed, was partly the result of the alterations in the style of printing the published specifications and drawings; and partly due to the lesser number of specifications printed.

The remaining appendixes consist of details of expenses, &c., and lists of places to which grants have been made of the Commissioners' publications.

THE ARGAN TREE.

Consul Drummond Hay, in his report upon Mogadore, the principal port of Morocco, mentions the existence of forests of the argan tree, which afford nourishment both for the natives and their flocks in the times of drought and scarcity. This remarkable tree grows only in certain provinces of the country, and is utilised in the following ways:—In the first place, the peasants extract the oil from the nut, which is useful both for burning and cooking purposes. When the nuts ripen and fall off the trees they are collected by the natives, who are aided in the harvest by their goats. Those animals swallow the fruit for the rind, but, being unable to digest the nut they throw it up again, and it is then added by their owners to the store for making the oil. For their private consumption the peasants rarely make a large quantity of oil at a time, but crack open a few handfuls of nuts with a stone, and after toasting the kernels in an earthenware dish, grind them to flour. The oil is extracted by adding water in small quantities to the flour, which is stirred in a bowl. As the oil is being formed by this process, the flour hardens into a cake, which is finally squeezed, leaving the oil perfectly clear and fit for use. This kind of oil-cake then serves as an excellent food for cattle, as does also the dry rind of the nut, which is generally given to them with the cake, forming together their principal and most nutritious food during the year. It is invaluable to the natives in time of drought, for the argan tree is very hardy, and a dry year has little if any effect upon it. Even the empty husk of the nut, when broken, is not thrown away by the peasants, but used as fuel. The best charcoal is made from the argan tree, and the dry timber is excellent firewood. The goats feed also upon the leaves of the tree, and when browsing in the argan forest may be seen climbing amongst the trees plucking and nibbling the nuts and leaves.

OBITUARY.

John Penn, F.R.S.—Mr. John Penn died on the 23rd September, at the age of 73. He was born in 1805 at Greenwich, where his father had during the close of the last century established a business as a machinist and agricultural implement manufacturer. He soon embarked in the business of a marine engineer. At the age of 20 he had fitted the steamers *Ipswich* and *Suffolk*, running to London along the east coast, with beam engines, each of 40-horse power, and in 1835, four passenger boats to run between Greenwich and London were similarly engined by him. In 1838, his oscillating engines with tubular boilers were applied to some of the boats running above London-bridge. In 1844, the Lords of the Admiralty placed their yacht the *Black Eagle* in his hands. He replaced her former engines by oscillators of double their power, with tubular flue boilers, the change being effected in the same space and without any increase of weight. The *Black Eagle*, by these and other improvements, from being a very slow ship had her speed so increased that an immense number of orders followed to fit up ships on the same principle. Another system with the introduction of which his name will always be associated is that of the trunk engine. In 1847, he was commissioned to fit her Majesty's ships *Arrogant* and *Encounter* on this system, and he executed these orders in a manner so satisfactory that as a result he has applied trunk engines to no less than 230 vessels. Up to the present time he and his firm had fitted 735 vessels with engines having an aggregate actual power of more than 500,000 horses. Amongst them the *Orlando, Howe, Belleropohon, Inconstant, Northampton, Ajax, Agamemnon, Hercules, Sultan, Warrior, Black Prince, Achilles, Minotaur*, and *Northumberland*. Mr. Penn became a member of the Society of Arts in 1853.

GENERAL NOTES.

The Sugar-cane.—It is announced that the authorities of Guadaloupe have offered a premium of 100,000 francs to the inventor of a process to obtain a yield of fourteen per cent. from sugar-cane. The competition is open until June 30, 1880. It is not for an improvement on sugar-mills, but for the discovery of a process bearing upon the yield of turbinated sugar. All the expenses of transit, putting up of machinery or implements, are to be borne by the inventor.

Preservation of Milk.—On the 9th of August, 1878, P. Cunliffe Owen, Esq., Secretary to the Royal Commission, and several scientific gentlemen, were present in the Food Department, British Section of the Paris Exhibition, when Mr. Hooker, F.C.S., attended and succeeded in churning butter in a few minutes from a specimen of milk prepared by him, which has been exposed to the action of the air for a period exceeding seven years, having been prepared in May, 1871. Butter has been churned on several occasions from this sample of ancient milk before the Food Committee of this Society, and the can of milk has been kept in the Society's house, except while it was removed to be shown at the various international exhibitions, since 1871.

Value of Ostriches.—A better proof of the importance of the newly-developed industry of ostrich-farming could hardly be given than the brief announcement made recently in the South African press that at a public sale of ortriches at Middleburg twenty pairs of breeding ostriches realised an average of nearly £200 per pair. The lowest price given for a single couple was £130, and as much as £285 was paid for one pair of birds. We believe even these prices have been exceeded in the case of well-known breeders. When it is remembered that a few years ago ostriches could be procured in South Africa for the catching, and were purchased for a mere trifle for exhibition purposes in this country, whereas at the present time a live ostrich does not exist in London, the importance of the birds on the ostrich-farms of Cape Colony may readily be realised. Even the Zoological Society of London does not possess a single specimen of the African ostrich; the late birds exhibited in Regent's-park were poisoned by the idiocy of visitors who, amused to see the birds swallow stones and other hard substances, used to throw coppers into the paddock, the consequence being that the birds were killed by the verdigris thus engendered in their crops. Even the eggs of the bird, once commonly collected as curiosities, are now hardly obtainable, being reserved for breeding purposes. And while such keen competition exists for the birds themselves, their produce is also eagerly sought for. At a recent sale of ostrich feathers at Port Elizabeth a parcel of selected "bloods" realised the fancy price of £67 15s. per lb., or about 15s. for each separate feather. Similarly high prices were paid for other qualities, and this notwithstanding a large increase in the supply. The following figures will show the rapid increase in this trade. In 1860 the quantity of ostrich feathers exported from the Cape of Good Hope was 2,297 lbs., valued at £19,261. Ten years later the quantity had increased more than twelvefold and the value fivefold. In 1873 the quantity was 31,581 lbs. and the value £159,679., while last year the value had increased to £393,406. —*The Colonies.*

Errata.—In Cantor Lecture published in last *Journal* for September 27th, 1878:—In line 37 from the bottom of column 2, page 917, for "Boudet" read "Boudet's." In line 32 from the bottom of column 1, page 918, for "Paggiale" read "Poggiale." In line 22 from the bottom of same column make same correction. In line 36 from the bottom of column 2, page 918, for "the Roman sold" read "the Roman butchers sold."

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,351. Vol. XXVI.

FRIDAY, OCTOBER 11, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

LIFE SAVING APPARATUS.

As there has been a prevalent misconception as to the date for sending in articles in competition for the medal, the Committee have extended the date from the 1st of August to the 31st of October instant.

DOMESTIC ECONOMY CONGRESS.

The Report of the Congress on Domestic Economy, held at Manchester in June last, has been published, and can be obtained at the Society's House, price 2s. 6d., bound in cloth.

The Report contains the Papers read at the Congress, with the Discussion thereon, the Rules and Regulations of the Congress, &c.

For the convenience of those who have already purchased the Pamphlet containing the Papers, which was issued at the time of the Congress, the part of the Report containing the Discussion, Rules, and Regulations, &c., has been issued separately, price 1s., in paper wrapper.

The Reports of the Birmingham Congress in 1877, and of the Manchester Congress in 1878, can be obtained, bound together, price 3s. 6d.

NATIONAL WATER SUPPLY. HEALTH AND SEWAGE OF TOWNS.

The Reports of the Congresses on the above subjects have been published in pamphlet form, and each report can be obtained at the Society's House, price 2s.

The Council of the Society of Arts are endeavouring to prepare a complete list of all the Reports of Medical Officers of Health which contain references to water supply. They will be much obliged if Medical Officers will communicate the dates of such reports, and, if convenient, send copies to be preserved in the library.

PROGRAMME OF EXAMINATIONS FOR 1879.

The Programme for 1879 is ready, and can be had on application to the Secretary. The Society's Examinations now comprise the following divisions.

1. Commercial Knowledge.
2. Domestic Economy.
3. Fine Arts applied to Industry.
4. Music.
5. Technology of Arts and Manufactures.
6. Elementary.

A Pamphlet containing Specimen Examination Papers in most of the subjects is published, and may be inspected by intending Candidates in the Libraries of the Institutions in Union with the Society; or copies may be had on application to the Secretary of the Society of Arts, price 6d.

MISCELLANEOUS.

ON SANITARY CO-OPERATION.*

By Sir Henry Cole, K.C.B.

Chaucer uses the word sanative, and so does Bacon; but sanitary, or sanitation, connected with the science of Public Health, is not nearly so old as our patriarchal president, Mr. Chadwick, who, I am inclined to think, was the father who invented the term sanitary science.

In this year of grace, we have sanitary newspapers —the *Builder* and the like papers—and here is a Sanitary Institute sitting which is not yet old enough to be recorded in "Whitaker's," or other almanacks, or such like registers.

There was once a Public Board of Health, and there may be again. The Society of Arts and other public bodies do duty for it, and discuss Health continually. In the meantime public opinion on sanitary questions of all kinds is gradually fermenting, and is still working its way. Health has even crept into the Revised Code of the Education Department, and public grants are made to encourage a knowledge of its principles according to rules, which make it difficult for schools to earn the grant. The Local Government Board virtually is responsible for doing what a public Department might do if it pleased, to advise upon and promote the health of the people throughout the kingdom; except in the metropolis, which is protected by Vestries and the representatives of Vestries, and as respects sewage can do nothing better than pollute the Thames with it, and suffocate unfortunate wretches who are immersed in it. The Local Government Board is afraid to do more than follow in the wake of public opinion—at a safe and long distance. Reports and returns are printed by Parliament, which are far more difficult to buy than a newspaper, or any sanitary paper, and are not systematically to be found even in Public Free Libraries—not in the excellent reference library at Manchester, or even in the British Museum, until a long time after publication. No authority is charged to make the information known. Our ancestors once stuck public notices of Acts of Parliament and proclamations on the church doors, but the practice is hardly followed now. And yet health and religion are companions, and the work of churches and chapels in all their phases of thought, which would, I think,

* A paper read at the Sanitary Institute Congress, held at Stafford, October, 1878.

be helped, but then the Home-office should take measures to inform the registered ministers of religion when all the publications which were issued by Government to promote a knowledge of public health appeared, and I venture to recommend this Institute to consider this suggestion, and, if need be, cause it to be discussed in Parliament.

Year after year Parliament makes laws permissive rather than obligatory, and the execution of them is a dead letter comparatively.

Mr. Cresswell, in an admirable paper read at the Health and Sewage Conference of the Society of Arts, last May, which should be carefully studied, observes "There has been a redundance of legislation embodied in a tortuous series of enactments." The Public Health Act of 1848, the Nuisance Removal Act of 1855, the Local Government Act of 1855, the Sanitary Act of 1866, the Sewage Utilisation Acts of 1865 and 1867, the Pollution of Rivers Act of 1876, and a consolidated Act, The Public Health Act, 1875; and, lastly, a Water Supply Act in 1878, brought in by Mr. A. H. Brown, the member for Wenlock. Mr. Cresswell continues to say, "Legislation has dragged its slow length along, while events have galloped with portentous haste, and neither imperial nor local effort keeps pace with the needs and expectancy of the nation. In 1876, popular excitement induced a palliative measure in the Rivers Pollution Prevention Act, but that measure has failed of its purpose, and given to wrong-doers a quasi-legislative sanction for their delinquencies and incapacity. At the same time, the Thames Conservancy Acts of 1857 and 1867, after much ado about nothing, have suffered a palsy, and received their *quietus*—for a time, at least —in the Lower Thames Valley Drainage Act of last year. In the meantime, a cry has gone up for water—water for the food and ablutions of man as well as the requirements of our great staple industries. Every river, from the Tay to the Dart, has been contaminated with the refuse of homestead or factory. The salmon kelts of Westmoreland and Cumberland are in process of destruction by a parasitic fungus plant, the newest development of sewage pollution; and, while professors dispute as to final causes, and means of prevention, the patient public waits for the *Deus ex machinâ*, in the form of some miraculous intervention, to save them from the natural consequence of their own apathy and ignorance. In presence of these and other startling phenomena, where shall we seek the signs of progress, or compute the net results of practical sanitation? . . . In this respect it may be expedient to reorganise the Local Government Department, and re-adjust it on its own proper bearings. Further legislation in this direction will rid us of that red-tape and circumlocution which encompasses every limb, and paralyses the functions of local bodies, reducing independent self-government to the shadow of an empty name. From the investigation of a grand scheme of arterial drainage to the contents of a workhouse plum-pudding, is a wide range of official supervision, yet nothing is too large or too minute for the elephantine prehension of the Whitehall department. There is a veritable plague of Inspectors abroad, and the native stubborness of the provincial mind, although it may need the spur and impulse of the central authority to set it in motion, resents this constant yoke of official supervision, which will not permit the expenditure of a few pounds, or the construction of a workhouse pigstye, without a local inquiry and departmental sanction. This was not the intent of those who framed the Public Health Acts, nor is the system compatible with the divine right of self-government. The functions of imperial administration end where those of local self-government begin; each has its proper uses in the economy of the State; and there is scope enough for each within its own particular province. The Rivers Pollution Prevention Act is in point. Such is the superfluity of safeguards and precautions in the provisions of that Act, that none save a Government department would venture to put it in force—nor can a sanitary authority take any proceedings under it without the consent of the Local Government Board. Here, then, was a field for the energies of Government, where both the resources and influence of the State might be usefully employed. Yet nothing has been done to enforce or direct the operation of an Act which is, as it were, stillborn, and truly a most lame and impotent piece of legislation! On the contrary, we can cite cases where local enterprise has been hampered; and official interference has blunted the edge of many a bold resolve on the part of those who have striven, humbly but honestly, to help themselves." What, then, can be done? We can say what ought to be done, but it may be years before impediments are removed and the work be done. So I offer some suggestions as a beginning; better, I hope, than remaining as we are. My suggestions will apply to the pollution of rivers by sewage, which, for the last two or three years, I have had reasons for studying.

You cannot remedy the pollution of a river unless you can get some federation of interests, and treat the river, from its source to its discharge into the sea, as a unit, and look to see that the whole work is done properly, in the interest of all the places which empty sewage into the river or its tributaries. Voluntary co-operation here, at present, is indispensable, and may be possible, but Government alone can make it obligatory, which it has shrunk from doing. Self-interest may be called into action. Take the case of the rivers Irwell, Irk, and Medlock, flowing through Manchester. Purification of the rivers in Manchester and Salford is paralysed because the towns above have not begun to remedy the nuisance of their own sewage, but send it down to pass Manchester on its way. Oldham and Rochdale have done nothing, therefore Manchester does nothing.

There is an instance nearer at hand which the Institute may examine on the spot. The Trent is at present made the common sewer for all the pottery towns from Tunstall to Stafford, rendering Trentham-hall almost uninhabitable. These towns are so independent and republican in spirit that they will not co-operate. Co-operation, as affording the best and cheapest way of proceeding, has been recommended by all the local surveyors. The towns know it well, but have it they will not; and each will have its own system, although at greatly augmented cost and reduced efficiency, with a great likelihood that, twenty years hence, the work will have to be reformed. Thus, Tunstall adopts a feeble precipitation system dirtily carried out. Burslem, the next town, adopts irrigation at very great and unnecessary cost, almost sure to be reformed in future years. Then Hanley has its own independent precipitation scheme of some kind, which will be burdened with sludge. Whilst Stoke-on-Trent, at every meeting of its Council for years past, has oscillated between irrigation, or filtration, or precipitation, or a jumble of all, one meeting undoing what the last meeting settled, whereas one main drainage along the River Trent and one outfall would have cleansed the pottery towns for all time and at far less cost in the end. But the towns flinch from doing the simple problem of arithmetic in settling among them the proportions of the cost!

Mr. Cresswell thinks there is a ray of light in the darkness afforded by the Bill lately before Parliament for the constitution of County Financial Boards or Local Parliaments in every county. Alas! this Bill never passed, and even if it had, I doubt if it could deal with a river passing through several counties like the River Trent. Each county would have to agree with several others in establishing one conservancy. The Trent begins in Staffordshire, passes into Nottinghamshire, then Lincolnshire, and gets to the sea in Yorkshire, collecting eighteen other streams besides several tributaries.

The House of Lords, on 23rd March, 1877, appointed a Select Committee to enlarge the powers of authorities over drainage and river navigation, "so as to provide

more efficiently for storage of water, the prevention of floods, and the discharge of other functions." The Committee consisted of the following most qualified members to judge on this subject:—The Duke of Richmond and Gordon (the Lord President), the Duke of Bedford, Duke of Northumberland, Marquis of Salisbury, Marquis of Ripon, Earl of Sandwich, Earl Cowper, Earl Stanhope, Viscount Eversley, Lords Monson, Vernon, Stewart of Garlies, Meldrum, Ker, Penrhyn, Somerton, and Winmarleigh. The Committee passed an unanimous report. They "entirely concurred with the witnesses that to secure uniformity and completeness of action in dealing with each river, each catchment area should, as a general rule, be placed under a single body of conservators, who should be responsible for maintaining the river, from its source to its outfall, in an efficient state," and are of opinion that the conservancy boards should be enabled to execute the powers for the prevention of the pollution of rivers, conferred on local authorities by the Rivers Pollution Act."

Purification of rivers is obviously connected with supply of good water, and both are connected with the proper preservation of water, and all should be under one authority.

Until public opinion emboldens the Government to adopt this wise principle, so authoritatively recommended that a whole river shall be under a single authority, and enforce it, I throw out for the consideration of the Institute, the suggestion if commercial principles may not be applied, at least to initiate a system of helping the purification of a whole river from its source to the sea. Commercial companies were formed to establish and work railways, and supply gas and water. If commercial companies had not been formed to provide railways, when would they have been started by our Government in this free country, which only follows public demands cautiously? Constitutional Governments do not originate measures.

A public company might be formed to manage the purification of the Trent on the best known scientific principles, with far greater economy and efficiency than the many towns, each by itself polluting the Trent, could do it. Such a company might deal not only with the sewage but the manufacturing refuse of all kinds.

We may hope that the letter which the Prince of Wales addressed to the Society of Arts, as its President, on the National Supply of Water, may start public investigations into the catchment basins of rivers, inquiries that will have useful connection with the Purification of the Rivers. In the meantime let private enterprise try what can be done, until Government, as with telegraphs and local intelligence, has ripened up for universal action in treating water sewage.

PUBLIC LIBRARIES IN PARIS.

An official report is made annually to the Minister of Public Instruction by the keepers of all the libraries in Paris, and the following is the list in round numbers of the number of books in each library:—Bibliothèque Nationale, more than 500,000 vols.; Bibliothèque de Archives, 20,000 vols.; Bibliothèque de l'Arsenal, 200,000 vols., and MSS., 8,000 vols.; Bibliothèque des Avocats, 12,000 vols.; Bibliothèque du Bureau des Longitudes, 5,000 vols.; Bibliothèque du Collége de France, 6,000 vols.; Bibliothèque du Conservatoire des Arts et Mètiers, 20,000 vols.; Bibliothèque du Corps Législatif, 50,000 vols.; Bibliothèque de la Cour de Cassation, 40,000 vols.; Bibliothèque de la Faculté de Droit, 9,000 vols.; Bibliothèque de la Faculté de Médecine, 35,000 vols.; Bibliothèque de l'Hôtel de la Monnaie, 2,000 vols.; Bibliothèque de l'Imprimerie Nationale, 3,000 vols.; Bibliothèque de l'Institut, 100,000 vols.; Bibliothèque des Invalides, 25,000 vols.; Bibliothèque du Louvre, 100,000 vols.; Bibliothèque du Ministère des Affaires Etrangères, 14,000 vols.; Bibliothèque Mazarina, 160,000 vols.; Bibliothèque du Muséum de l'Histoire Naturelle (Jardin des Plantes), 35,000 vols.; Biblothèque Sainte Genevieve, 170,000 vols.; Bibliothèque de l'Ancien Sénat (Palais du Luxembourg), 20,000 vols.; Bibliothèque de la Sorbonne, 125,000 vols.

All the hospitals of Paris have their libraries founded within a few years by house and pupils. In the various Government establishments there are also libraries, making in all a total of more than a million and a half volumes.

The public libraries in the departments contain about four million volumes.

Far more important than mere numbers is the fact that, in Paris especially, but generally everywhere in France, the public libraries are open to all, and well frequented, but they leave much to be desired in the way of catalogue; and open reference libraries, like that in the British Museum reading-room, exist nowhere, that we are aware of, but at the Bibliothèque Nationale of Paris, and there it is on a small scale.

THE PRODUCTS OF COMBUSTION OF COAL GAS.*

Now, for coal gas itself. If you take a specimen of coal gas which has a specific gravity one-half that of air, or ·5, a cubic foot of such gas contains about half its weight of carbon; and, if this cubic foot of gas be burnt, it will give a little more than half a cubic foot of carbonic acid. The precise number is ·55, or, in weight, 488 grains. With regard to the hydrogen, a cubic foot of coal gas, of ·5 specific gravity, contains about 41 grains of hydrogen, and this hydrogen in burning will produce 372 grains of water. If we regard the quantity of air necessary to supply the requisite quantity of oxygen to a cubic foot of gas, it lies between five and six feet of air. For every cubic foot of gas burnt we require the entire oxygen of between five and six cubic feet of air, and this will give half a cubic foot of carbonic acid as a result. If we compare this with the amount of carbonic acid given off by respiration, we obtain the following relation:—If five cubic feet of gas are burnt in one hour, we get from them 2·7 feet, or rather more, carbonic acid. If an adult human being breathes for the same period of time, he exhales with his breath about ·7 cubic foot of carbonic acid, about one-fourth of that given off by a gas-burner burning five cubic feet of gas. Now, the quantities of carbonic acid and water; given off by one cubic foot, or even five cubic feet, appear relatively small; but, if we come to deal with the quantity of gas used, say, in London annually, the amounts are somewhat astonishing—the figures are really startling. The quantity of gas consumed in London annually may be taken approximately, at present, at about 15 millions of cubic feet. The amount of carbonic acid given off during a year by the combustion of those 15 millions of cubic feet amounts to 433,000 tons. That quantity is discharged into the atmosphere by the combustion of the coal gas consumed in London, an amount which contains as much carbon as would be found in the wood growing in a forest of considerable dimensions. The amount of water produced by the combustion of this quantity of coal gas is 360,000 tons, or 80 million gallons, one of the largest, if not the largest gasholder-tanks in London is at the Phœnix works at Kennington. That gasholder-tank, supposing it had no internal cone, and were perfectly flat at the bottom, would hold 10 million gallons of water, if filled to the brim. You might empty that tank and fill it eight times over in a year with the water produced by the burning of the coal gas consumed in the metropolis during that time.

* Extracted from a lecture recently delivered before the British Association of Gas Managers, by Thomas Wills, F.C.S., F.I.C.

Now we have to consider the effect of these results upon the vitiation of the atmosphere. The amount of carbonic acid in the air, ordinary normal air, is ·04 per cent.; in other words, four volumes of carbonic acid are contained in 10,000 volumes of air. Now, if we increase this proportion to ·06, we arrive at what may be set down as the healthy limit, and we ought not to go beyond it; in other words, six volumes of carbonic acid in 10,000 of air. As a matter of fact, even in our best buildings, it is found under present circumstances almost impossible to keep the carbonic acid even as low as that, and for the purpose of calculation I am going to take as much as ·1. Now, ·1 per cent., or 10 volumes in 10,000 cubic feet, means this—that you may introduce into 10,000 cubic feet of air the difference between four cubic feet and ten cubic feet before you arrive at this amount of vitiation. In other words, you may discharge into 10,000 cubic feet of air six cubic feet of carbonic acid. You then reach the limit, which, as I say, is really beyond a healthy limit; for an atmosphere containing ·1 of carbonic acid is a bad atmosphere, and anything beyond it is excessively bad.

Now five cubic feet of gas burnt will give off 2·75 cubic feet of carbonic acid, and the amount of air into which this amount of carbonic acid may be discharged, in order not to exceed the limit of ·1 per cent., will be 4,500 cubic feet; in other words, for the combustion of five cubic feet of gas we require the special use of 4,500 cubit feet of air, supposing the air is not changed. One adult human being discharges by respiration ·7 cubic foot of carbonic acid per hour, and the quantity of air which he will require the use of, in order not to exceed the limit of ·1 per cent., will be 1,166 feet. So that if we start with a room of 5,660 cubic feet capacity, then we may allow a gas-burner to consume five feet of gas in that space, and an adult human being to breathe for one hour, before we reach the limit. But when we have reached that point, where all the air is so far vitiated, it must either be renewed entirely or the vitiating influence must be put an end to.

Now, take the room in which we are assembled.* This large room contains, in round numbers, 60,000 cubic feet of air. The external air may be taken to have the normal amount of carbonic acid in it of ·04. We may, then, vitiate with impunity, that is, without passing beyond this limit of ·1 per cent. of carbonic acid, up to that extent. Thus we may introduce into this room 36 feet of carbonic acid before we shall reach the limit of ·1 per cent., supposing the air in the room not to be changed. Now, if 10 gas-burners, each burning five cubic feet of gas, were burnt in this room for one hour, and 10 men remained in the room for the same period, these 36 cubic feet would be given off; in other words, 10 gas-burners burning five cubic feet each, and 10 men breathing for an hour, would bring up the proportion of carbonic acid in this room to ·1 per cent., or outside the limit of anything which can be conceived to be a healthy state of things. Now it is not at all an unusual circumstance for 25 gas-burners and for 100 men, as we are to-night, to be assembled in such a room, and, if we take these figures, we shall require for combustion the use of 112,500 cubic feet per hour, and for respiration 116,500 cubic feet—both together being 229,000 cubic feet of air required for these purposes alone—in order that we shall not exceed that limit. In order words, the entire contents of this room must be changed four times in the hour to keep down the proportion of carbonic acid to the limit of ·1 per cent., or 169,000 cubic feet of air must pass into and out of the room every hour in order that this shall not be the case. Now, any current of air that travels at the rate of more than 16 inches per second is a draught; and it is obvious, from this fact, that the air in this room cannot be changed by any such forcible means. Direct currents of incoming and outgoing air do not, by any means, represent the amount of change going on. There is a process of diffusion taking place constantly through the walls and the ceilings and floors of our dwellings, and this process, although not recognised, and although continuing its action in silence, is an exceedingly important one, and is really a saving process for us who have to live occasionally in rooms not artificially ventilated. The process of diffusion may be stated to consist in the tendency which all gases have to become intimately and permanently mixed; and the process goes on through porous substances, and through other substances which we do not usually regard as porous. I may illustrate the matter to you by a very simple experiment. I have here a tube, closed at the upper end by a block of gypsum or plaster of Paris a little more than a quarter of an inch thick, and this glass tube is in communication with this upper receiver. I shall fill the tube with hydrogen gas, and I will place the lower end under the service of some coloured water. The inner part of the tube will be filled with hydrogen, outside will be air. The hydrogen will diffuse or tend to pass through the pores of the plug into the surrounding air, but the hydrogen will pass through faster than the air enters, and the consequence will be that a reduction of pressure will be caused inside the tube. If this be so, the column of water will rise, which will show you the effect. It is now filled with hydrogen gas; I immerse it in the coloured water; we will leave it for a few moments, when you will find the coloured water will rise in the tube. This means that there must be less pressure inside the tube than there is on the surface of the water; and this is due to the fact that the hydrogen is escaping through the pores of the plug faster than the air is entering. This is an illustration of the same process that is going on through our walls and ceilings.

Now the rate of diffusion varies inversely as the square root of the density. Its rate is dependent, therefore, on the density, so that any means by which we can alter the density of our air or gas will produce an effect on its diffusion. If you have two gases, one on one side of the porous plug, and one on the other, the greater the difference in the density, the greater will be the speed of diffusion. Now, there are two things which tend to alter the density of air within our buildings; those two are — first, an alteration in the composition which takes place in the air; and, secondly, the elevation of the temperature. Now the alteration in the composition comes from the discharge into air of water and of carbonic acid; but the alteration is small, and may, as far as regards its influence or diffusion, be neglected. The elevation of temperature comes from the heat of our combustible fuels, and also from the heat of our bodies, and the greater the difference of temperature which we can get between the air inside and out, the greater will be the speed of this diffusion. But we shall find, as the rate of diffusion does not increase proportionately to the ventilation, we shall gradually overtake the rate at which it is taking place. Consequently we shall, after a short time, arrive at a limit beyond which the process of diffusion will be unable to help us, and from which point we shall begin to vitiate our aim more and more. The heating effect of gas and of sperm oil is about equal, light for light; the heating effect of paraffin oil and candles is about the same, but greater than coal gas and sperm oil. Of the materials which can be classed as ordinary building materials, those which permit the diffusion to go on most rapidly are:—First, the material which is occasionally used, I am afraid, in the building of some of the houses in the suburbs—I refer to dried mud. That is a substance through which diffusion takes place with the greatest ease, much greater than through ordinary bricks or stones. Next to mud come bricks. Bricks allow diffusion

* The large room of the Society of Arts.

to go on with a very considerable amount of rapidity and ease, almost as easily—easier in some cases—than through this plug of gypsum. You can see the ease with which the hydrogen finds its way through by the height to which the water has risen, representing 16 or 18 inches water pressure. Next to brick we have limestone; and, lastly, sandstone. This is the order in which you can take building materials. I would state here that, in my opinion, it is high time that architects and builders should be called upon to recognise that it is absolutely necessary to ventilate not only large buildings, but every room in a house in which persons may have to remain for some time, more especially those in which artificial illumination is used. If it were not for this process of diffusion the matter would long ago have become imperative, because there would hardly be a room in which, after a little time, it would be possible to live; but so long as this condition is not arrived at, all concerned seem willing to allow things to remain much as they are.

The process of diffusion, although it has been a saving element in this matter, has been, at the same time, rather a snare, because when we lose its influence we find it becomes absolutely imperative to get air in some other way. When we descend a coal mine, we have no diffusion whatever to help us, and all the air which is required there for the respiration of men employed, and for the combustion of their illuminating fuels, must be sent directly down the shaft; and what is the consequence? That an enormous quantity is found to be required, much more than is conceived to be necessary on the surface—much more than is necessary in fact. As much, in some of the northern pits, as 350,000 cubic feet of air is sent down per minute. This is needed, because they are not able to rely upon any other source below.

The air of a room cannot be conveniently changed more frequently than from three to four times per hour, and it should be seen always that the vitiating influence is not in excess of this rate of diffusion. Further, the oppressiveness of a room, the effect which it has of producing headache and nausea, is not due only to the presence of carbonic acid and moisture. You may go into a soda-water manufactory, in which there is a very much larger amount of carbonic acid in the air than in any of our rooms which are even imperfectly ventilated, and you do not suffer in the same way as you do from remaining in an ordinary ill-ventilated room. The reason of that greater oppressiveness of our rooms is due to the presence, I think, of organic matter. Now, this organic matter is exhaled in the breath, and is given off by all our illuminating fuels; and it is this organic matter in the air which produces the feeling of depression which we all feel on remaining for some time in a room which is ill-ventilated. The amount of unburnt carbon products given off by coal gas, for example, is very large, and it is very probable that those burners which give out the greatest amount of light really give out the greatest amount of unburnt carbon products into the air. The amount of organic matter in the air will be proportionate to the amount of carbonic acid discharged either by respiration or combustion, and hence it may fairly be taken as a measure of the badness of the air.

I have purposely omitted, up to this point, all mention of the sulphur which coal gas contains, and which, as an illuminating agent, is peculiar in this respect. I propose, with your permission, to detain you for a few moments, while I deal with the subject of sulphur in coal gas. In any considerations of the vitiation of air by the products of the combustion of coal gas, this sulphur must be taken into account. It occurs in the gas, in some form of combination, as most of you know, I apprehend, in some other form than of sulphuretted hydrogen. Undoubtedly, some part of it occurs there as bisulphide of carbon; but I do not think, by any means, that the amount of bisulphide of carbon accounts for the whole of the sulphur. In same cases, I believe, it accounts for a very small portion of it. But whatever form the sulphur may be in, when the gas is burnt, that sulphur burns into sulphurous acid. There is a very considerable difference of opinion as to the precise state in which the sulphur is introduced into the air, some gentlemen affirming that it is sulphurous acid, others that it is immediately oxidised to sulphuric acid, and some, indeed, maintain that sulphuric acid is the product of the combustion of sulphur when it is burnt at the same time with hydrogen; that is to say, that when water is formed at the same time, sulphuric acid results, and not sulphurous acid. My own decided opinion is that the sulphur is at first all burnt to sulphurous acid, that then a certain portion of this sulphurous acid is oxidised into sulphuric acid, and that the amount so oxidised depends upon circumstances; but that, given a sufficient length of time, the whole of the sulphurous acid will be oxidised into sulphuric acid. Now as to the circumstances. If the sulphurous acid is kept hot in the presence of moisture, then oxidisation goes on more rapidly; if it be cooled down almost immediately after it is formed, the action is very slow, and within any reasonable time it will be found impossible to entirely oxidise the whole of the sulphurous acid into sulphuric acid. Then, secondly, if the sulphurous acid meets with a base or with an easily-oxidisable substance with which it can unite, it undergoes oxidisation much more rapidly than if it remains in the state of free acid. There is no doubt that metal fittings, if used in contact with the products of combustion from coal gas, do become corroded with sulphuric acid. Here is some sulphate of zinc, which I myself obtained by burning London coal gas under a small zinc hood. You can also obtain sulphate of copper by burning coal gas, as most of us chemists know, under the surface of a copper water-bath. There is no doubt whatever of this, but then we are dealing with this circumstance which I have mentioned; we have an easily-oxidisable substance present, a body which can unite with sulphorous acid and form a salt, and, under these circumstances, oxidation goes on very much more readily than otherwise. Thirdly, if sulphurous acid, water, and air are be absorbed into a porous body, then oxidation goes on more rapidly, because the air and the sulphurous acid and water are brought into closer contact; and I believe this is why leather bindings and leather goods generally are always brought so prominently to the front, with regard to the matter of contamination by the combustion of the sulphur compounds in coal gas. It is due to the fact that you are dealing with a very porous substance, and the same thing being repeated again and again, you do in time get a certain amount of damage produced; but that this damage is anything like what is generally represented, I beg leave very much to doubt. From my own experiments, I believe that, under ordinary circumstances, considerably less than one-half of the sulphurous acid produced by the combustion of coal gas is oxidised in any reasonable time into sulphuric acid, and in this I am supported by several gentlemen, who, not being connected with the coal gas industry, are, nevertheless, thoroughly acquainted with the behaviour of sulphurous acid when used in the manufacture of alkali.

With regard to the question of sulphur in gas. You remember we concluded a short time ago that the air of a room must be constantly changed, or we could not exist, and that the change must be going on several times in each hour; the whole atmosphere must be changed generally more than three times in each hour. Now, supposing sulphur is burned into sulphurous acid, and that it exists for even a part of an hour, as such, in the air uncondensed, it will come under the ventilating effect, and will undergo removal just in the same way as the aqueous vapour or the carbonic acid present in the air. If one-half of the sulphur remains

in the gaseous condition for only one hour, it will be entirely removed within that period. I believe most of the ordinary effects which are attributed to the presence of sulphur in coal gas, and the damage that it does, are quite easily accounted for by other things. I believe the constant drying and wetting, coupled with the elevation of temperature, and the presence of carbonic acid—effects which result from all illuminating fuels alike—are quite competent to account for the greater amount of the damage which is represented as being solely due to the presence of sulphur. If we regard the absolute quantity, the figures become exceedingly minute, even if you have 20 grains of sulphur in 100 feet of gas. Supposing it to exist in the form of bisulphide of carbon, here is such a quantity of bisulphide containing 20 grains of sulphur. The quantity in this little tube, about an inch of it, represents 20 grains of sulphur, or the amount which we may take as being present in 100 cubic feet of our London gas. Now, I could, if I had time, burn the whole of this quantity at once, and you would have all the sulphurous acid from it discharged into the air, and that would represent the sulphurous acid from 100 cubic feet, but I believe it would be impossible for you to find out the sulphurous acid, although it is there. Undoubtedly it is there, but it is diluted to such an extent that you could not find it by any ordinary test. If 20 grains of sulphur burn they form 40 grains of sulphurous acid; a cubic foot of sulphurous acid would weigh 1,184 grains. Now, the thirtieth part of a cubic foot of sulphurous acid is produced by 20 grains of sulphur, or the amount in 100 cubic feet of gas, and I may say that such a quantity in this room, supposing the room to contain approximately 60,000 cubic feet, would be represented by the block I hold in my hand, about 3¾ inch cube, and which, if diffused through the entire room, would amount to about one-half part per million in volume, or about ·000001 per cent. in weight. If a proper arrangement were adopted to carry off the products of combustion, there would be no more complaints of sulphurous acid, and I believe that proper care ought always to be taken that coal gas ought not to be burnt, in anything like quantity, without such arrangements being adopted. If this were done, all danger from damage by sulphur, even if it existed in greater quantity than it does, would be at an end, but I expect it would be found, supposing you could find out how to take the whole of the sulphur out, the complaint of the damaging effects would continue for some time just the same.

I may say, with regard to the per-centage, it has been found that in the Manchester atmosphere, over a range of four miles, the amount of sulphur present normally in the air would be about equal to the quantity which would be formed in this room by the presence in it of this amount of sulphurous acid; consequently, the whole atmosphere of that town we should expect to be doing damage by sulphur. If we regard the amount of coal burnt here in London, 8,000,000 tons per annum, and if we take that coal to contain 1 per cent. of sulphur which is burnt—whether in the form in which you send send it into houses in gas, or in furnaces, or in grates, it is burnt in some way—and which is a low average, we shall have 80,000 tons of sulphur thrown into the air in the form of sulphurous acid; and if that is calculated into oil of vitriol, it will amount in one year to 240,000 tons of oil of vitriol sent into the atmosphere of London alone by the combustion of coal.

The extraordinary persistency with which unsuccessful candidates present themselves year after year at the Chinese competitive examinations is curiously illustrated by certain edicts in the *Pekin Gazette* of last year, in which honorary degrees are conferred on 42 candidates who were finally plucked at the age of 90 and upwards, and 136 who gave up the struggle when between 80 and 90.

THE GUTTA-PRODUCING PLANTS OF THE MALAY PENINSULA.

In an appendix to a report of an expedition to Perak, recently made by Mr. Murton, the superintendent of the Botanical Gardens, Singapore, a good deal of information is given regarding the sources of the different kinds of gutta produced in the Malay Peninsula. Five varieties are enumerated, and their respective values in Perak and Salangor given as follows:—

	Price per picul. In Perak.	In Salangor.
1. Gutta-soosoo	50 to 52 dols.	not known.
2. Gutta-taban	45 to 50 ,,	50 dols.
3. Gutta-rambong	32 to 35 ,,	not known.
4. Gutta-singgarip	17 to 20 ,,	20 dols.
5. Gutta-putih-sundek	15 to 30 ,,	15 ,,

Of the first—gutta-soosoo—Mr. Murton was unable to obtain any samples of the tree producing it, and the only information he could gather concerning it was that the tree is entirely destroyed, except in the interior of Perak; that the gutta is firmer in texture than gutta-taban, and contains a little oil. This must not be confounded with the gutta-soosoo of Borneo, which is a caoutchouc or rubber.

The second, or gutta-taban, is the gutta-percha of commerce, and the product of a tree described so far back as 1837, by Sir William Hooker, under the name of *Isonandra gutta*, but now known to botanists as *Dichopsis gutta*, Bth. It appears that, in Perak, there are two sorts, alike in foliage and general appearance, and differing only in the colour of the flowers, one being white and the other red. They are known to the Malays by the names of *Ngiato putih* and *Ngiato merah*, but the products of both trees are called gutta-taban. *Dichopsis gutta* is most abundant on Gunongs Meeru and Sayong, and Bujong, Malacca. A few large trees still exist on Gunong Babo and the Thaipeng range. Small plants, from one to eight feet, are abundant on the granite formations in Perak up to 3,500 feet elevation.

To procure the milk, the tree is cut down at five or six feet from the ground, and the top cut off immediately, when it becomes too small for ringing. This, the natives say, causes the tree to yield a much larger quantity. The bark is then ringed with small knives called "golos" at intervals of from five to fifteen inches. The milk continues to flow for about an hour, and is collected in vessels made of palm leaves or cocoa-nut shells, and then boiled for about an hour, otherwise it becomes brittle and useless. Regarding the quantity of gutta each tree is capable of producing, no trustworthy information seems to have been obtained. One of the principal merchants of Perak informed a member of the expedition that a large tree will yield forty catties of gutta, but Mr. Murton regards this as an exaggeration, for from numerous inquiries among the men in the jungles he was told that from five to fifteen catties is about the average quantity obtained, and never more than twenty catties. No particular season seems to be recognised in Perak for collecting the gutta, and Mr. Murton was unable to glean any information as to whether or not the trees yield more in one season than in another. He considers, however, that in the wet seasons the gutta contains more water, and consequently would require more boiling to drive it off. It is stated that from Klang 83 piculs 83 catties were exported from January to November, 1877; so that it is probable over 700 trees were destroyed to furnish that quantity. The gutta is generally, if not always, exported in the shape of oblong balls, with a loop at the upper end, through which a piece of rattan is put to facilitate its being carried through the jungles. These balls vary considerably in weight, but from 10 to 20 catties is about the average. They are of a greyish-white colour, with a slightly reddish tint inside. The colour, however,

varies according to the quantity of bark and other impurities mixed with it; sometimes it is of a bright umber brown.

For the cultivation of *Dichopsis gutta*, it is recommended that plants not more than a foot high should be procured from the jungles; it is necessary to lift them very carefully, as they have long tap roots which are liable to be broken or injured, in which case, the plants, even if they survive, take a long time to recover.

The third kind of gutta, namely, gutta-rambong, is described as being more of the nature of caoutchouc, or india-rubber. Mr. Murton did not find the tree producing it, and he was informed by the Malays that it was only to be met with in the interior of Perak, and on the Patani side of the Peninsula. These people describe the tree as having large roots above ground, and large, bright green leaves, with red tips to the branches. The milk is obtained from these large roots, which are tapped ten or twelve times a year, a picul being sometimes taken from a large tree; the usual yield, however, is said to be about half a picul. This rubber is said to require no preparation for market. It has the appearance of long strings irregularly welded together; the best quality has a gum-like appearance, is very firm in texture, and of a reddish-brown colour; the inferior qualities have a large admixture of bark, &c., and are much drier, without the gum-like consistency of the better qualities. The caoutchouc from Perak has much the same appearance as Assam rubber, and Mr. Murton considers there is but little doubt that it is produced by the same tree, *Ficus elastica*, the description given by the Malays agreeing closely with that of the above-named plant, the red points to the branches being probably the conspicuous red stipules which envelope the young leaves. From the fact that young plants have been promised to the Singapore Gardens, it is to be hoped that ere long the origin of gutta-rambong will be definitely settled.

Another caoutchouc or india-rubber is gutta-sing-garip. This agrees very closely in texture, appearance, and in the mode of operation with the gutta-soosoo of Borneo, and Mr. Murton says that an experienced authority, who had spent some time among the gutta-soosoo collectors in Borneo, assured him that they are one and the same product. The plant producing it is a large woody climber, with stems about six or eight inches in diameter, but often much less. There are two varieties; one with very dark coloured outer bark and lighter coloured warts, and red inner bark; and the other with outer bark light cork-coloured, with longitudinal channels, and the inner bark light yellow. The foliage of both plants are described as being very similar to each other, but the fruits differ in form, one being apple-shaped and the other pear-shaped. The fruits of both forms are edible, and are readily sought after by the Malays. The plants seem to be species of *Willoughbeia*, belonging to the natural order, *Apocynaceæ*. The gutta from the dark-barked variety is considered the best. The long, scandent stems are often cut down to procure the milk, but it is not absolutely necessary to do so, except to render the operation of collecting the gutta easier. The stem is generally ringed at intervals of 10 to 12 inches, and the milk allowed to run into vessels made of palm or other leaves, cocoa-nut shells, or anything available for the purpose; it continues to flow for some time, but after flowing for ten minutes it gets very watery and thin. One plant will yield from five to ten catties of the coagulated caoutchouc. When raw it has the appearance of sour milk, and to coagulate it the natives add salt or salt water. When freshly coagulated it is quite white, but gradually changes to a darker colour. It retains its white colour inside, and upon cutting it is found to be porous, the pores or cells containing water and salt, which have become enclosed during coagulation. In texture it is soft, very spongy, and very wet. From January to November, 1877, 57 piculs 45 catties of this rubber were exported from Klang alone. Gutta-putih, or gutta-sundek, is the produce of a species of *Dichopsis*, the leaves of which differ from those of *D. gutta*, in being much shorter, broader, and more ovate in general outline. The gutta is obtained and prepared in the same manner as gutta-taban, and trees are frequently met with on the Sayong and Meeru ranges. Of this variety 484 piculs 56 catties were exported from Klang alone, from January to November, 1877. It is much whiter and more spongy than gutta-taban, and is worth only 15 dols. per picul, as against 50 dols. for gutta-taban. In concluding this interesting report, Mr. Murton says:—"When crossing the Meeru range from Kinta to Kwalla Kangsa, I cut off some leafy branches from a tree which had been felled and ringed a few days before. These leaves were beautifully yellow on the lower surface, caused by small peltate scales, and not pilose hairs, as in the *Isonandras* (*Dichopsis*), but on making inquiries from men about Sayong, they pronounced them to be foliage of some non-gutta yielding tree, which is certainly wrong, as I saw the dry gutta adhering to the bark where it had been ringed. A kind of gutta, called gutta-jalutong, is often used in Perak for mixing with guttas taban and putih, thus rendering them very brittle, but I have not seen the gutta, nor the tree producing it. *Isonandra Motleyana* is said to yield a gum which, in Java and Sumatra, is known as gutta-kolian, and is used only for adulterating purposes. Various species of fig (*Ficus*) yield large quantities of milk, which in Perak is known as gutta-burong, as the only use to which it is put is for bird-catching."

From the foregoing remarks, it will be seen that there is a great deal yet to be learnt about the sources of those valuable plants and trees yielding elastic gums, and it is to be hoped that, with an extended knowledge of the plants themselves, increased supplies may also find their way into commerce.

NOTES ON THE COLONIAL EXHIBIT OF SILK AT THE EXHIBITION OF PARIS.

Taken as a whole, the specimens of cocoons and other products of silk culture are extremely disappointing. It might have been expected that in sending specimens to a silk country like France the very best productions of the Colonies would have been exhibited, but in nearly every instance the specimens submitted some years ago to the Silk Committee of the Society of Arts were superior to these now shown. Since that time the races seem to have been allowed to degenerate rather than not, and the cultivation of silk to have become an amateur's hobby rather than a useful pursuit for a practical purpose.

Naturally, one who listened to Mrs. Neill in the theatre of the Society, and heard her explain the great capabilities of the colony of Victoria, looks for her exhibit, and expects to find encouraging results from the acclimatisation of Mons. Roland's graine. Mrs. Neill is conspicuous by her absence, and does not exhibit at all, and Victoria is represented principally by Mrs. Ann Timbril, whose mixed cocoons show that the worms have been bred without judgment, and whose dyed floss is what might have been tolerable silk had it not been spoiled. The whole of the cocoons from Victoria are mixed—good and bad together, ruining the whole as specimens, and "education" has neither been accorded to the worms nor the rearers.

New South Wales is more encouraging, but the exhibit of Messrs. Fry and Sons leaves much to be desired; mixed races, mixed qualities, mixed colours; everything mixed but values, which adhere to the lowest grades. Charles Thorne shows a better value in his specimens. Some of these cocoons are of excellent quality, but the excellence is fitful and changing, but they evince either a want of knowledge in the rearing, or

a want of the proper description of food at the critical time before mounting.

A small exhibit from Ballarat, by Mrs. Piper, deserves commendation, being a small, well-selected lot, and would compare fairly well with some of the exhibits of France; but in this there are dupions which should not have been admitted. Better knowledge on the part of the rearer would correct this in the future.

From the Cape the same tale has to be told, and the exhibit is very different from that which took the gold medal of the Society to the same exhibitor only a few years ago. The cocoons are large, but poor in silk, and soft, and show either a want of food or of care in the rearing. At the Cape one would suppose that with ordinary care the former would be impossible.

The American exhibit is worse than that of our colonies, and the less said of it the better, beyond recording the fact that there are no specimens of any sort from California.

Algeria makes a magnificent display, and the cocoons exhibited here show what can be done in a country less favourably adapted for silk culture than many of our colonies. It would be well worth the while of the Colonial Commissioners to take back with them the seeds or graine of these magnificent cocoons, the more so because the temperature of Algeria would necessarily render these acclimatised races more fit for that of the colonies than grain from further north. Such results as Algeria shows are well worthy of commendation; and if Algeria can produce such, why should not Australia, with its many advantages? Care and a better knowledge are the only things required.

In another part of the building, the exhibit of Algiers silk by E. Dotte gives a good idea of what this product can be worked up to, and is well worthy of attention.

Among the very interesting silk exhibits from a colonial point of view are those of Spain, especially that of the Yama Mai silk, exhibited by the Marquis de Riscal; the skein of silk from these oak feeders is magnificent. The exhibit is further interesting as showing cocoons in the bush, and by the "system of installation," in compartments.

Japan exhibits the Yama Mai in its different stages, but also the oak wood, the leaf, the moth, the cage, making in fact, an illustrated history of the Attacus Yama Mai.

In the Lyons exhibit, the skein of silk reeled from dupions is a novelty, and may add to the value of such cocoons. Of course, it is impossible to say how this silk will work from merely seeing it through glass.

Upon the whole, the conclusion is inevitable that, while most of the colonies may become silk-producing countries, with very little trouble, the industry at present is, from some unexplained reason, not sufficiently popular to be taken up with anything like energy and determination. It is to be hoped that Mr. Jules Joubert, on his return, may devote some of that energy for which he is renowned to this important addition to the resources of our colonies.

THE IMPORTATION OF AUSTRALIAN FRUITS INTO ENGLAND.

The appearance, at the Paris Exhibition, of a collection of well-known European dessert-fruits, produced in Australia, has excited a good deal of interest, in view of the prospect of these choice fruits becoming regular articles of trade between that country and this. It is well known that pears, apples, peaches, and grapes are, and have been for some years, grown to splendid perfection in Australia. These, together with cherries and other stone fruits, form a part of the collection shown at Paris, and were, it seems, forwarded from Sydney, Melbourne, and Adelaide. Though they were subjected to much delay and unnecessary risk of injury, they, nevertheless, arrived in good condition. "This success," we are told by a contemporary, "has led to the proposal that the produce of the orchards and the fruit-gardens of the southern portion of the empire should be more generally brought within reach of the less favoured lands in the north. Already we receive large quantities of delicate fruits in a fresh state, as well as preserved in various ways, from the islands of the Atlantic and from the Far West, and occasional packages of fruit come from the Cape; but Australia has hitherto only been able to send us her more delicate produce in the shape of jams and preserves, and there are obstacles to the full development of this branch of trade. By taking proper advantage, however, of the facilities of transport now afforded by the quick steamers trading between Australia and England, both *viâ* the Cape and the Suez Canal, there is every probability that, with careful packing and judicious stowage, the choicest fruits of Australia and Tasmania, and of Fiji, as well as of South Africa, could be brought, in perfect condition, to adorn the dessert-dishes of the old country."

NOTES ON BOOKS.

The Speaking Telephone, Talking Phonograph, and other Novelties. By G. B. Prescott. New York: D. Appleton and Co. 1878.

Nearly three-quarters of this work are devoted to the telephone; a chapter is given to the phonograph; and the "other novelties" mentioned in the title consist of "quadruplex telegraphy," "electric call bells," and the "electric light," to each of which a chapter is given. Much of the material of the book has already appeared in print; thus we have Graham Bell's lecture before the telegraph engineers, papers by Elisha Gray, Dolbear, and others. The first, or introductory chapter, is a *résumé* of the history of telephonic discovery, and hence it is, to a considerable extent, occupied by a discussion of the claims of the different inventors, who all seem to have had a share in originating and perfecting the telephone. Bell, Gray, and Dolbear all have their partisans, and, as is usual in cases of disputed priority of invention, each party claims for its candidate the whole credit, and denies to the others any share whatever. Whoever, indeed, may have first attained success, it is evident that in this instance, as in so many others, we have a number of minds all working at the same idea, doubtless independently, and there is every reason to feel assured, in ignorance of one another's researches. Gray and Bell almost simultaneously patented apparatus closely alike, for transmitting human speech, though it is curious that, on their showing, they were led to similar results by widely differing lines of research. In England Bell's telephone seems to have it all its own way, at least so far that it keeps other inventors out of the field, if it does not itself occupy the place it might do, but in the States there seems more competition. Gray's telephone seems to be extensively used, and so also, Mr. Prescott tells us, are some modified forms of the Bell, which he considers much superior to the original form. As is well known, in America the telephone has become a really serviceable instrument, instead of remaining, as in this country, merely a scientific toy. Mr. Prescott gives several drawings and descriptions of the arrangements employed for fitting up telephones in connection with call bells and batteries, these being, according to him, the only means as yet adopted in America for calling attention.

Besides descriptions of existing instruments, there are full accounts of the earlier researches of Gray, of the inventions of Reiss and others. The book is fully illustrated throughout.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,352. VOL. XXVI.

FRIDAY, OCTOBER 18, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

LIFE SAVING APPARATUS.

As there has been a prevalent misconception as to the date for sending in articles in competition for the medal, the Committee have extended the date from the 1st of August to the 31st of October instant.

DOMESTIC ECONOMY CONGRESS.

The Report of the Congress on Domestic Economy, held at Manchester in June last, has been published, and can be obtained at the Society's House, price 2s. 6d., bound in cloth.

The Report contains the Papers read at the Congress, with the Discussion thereon, the Rules and Regulations of the Congress, &c.

For the convenience of those who have already purchased the Pamphlet containing the Papers, which was issued at the time of the Congress, the part of the Report containing the Discussion, Rules, and Regulations, &c., has been issued separately, price 1s., in paper wrapper.

The Reports of the Birmingham Congress in 1877, and of the Manchester Congress in 1878, can be obtained, bound together, price 3s. 6d.

NATIONAL WATER SUPPLY.
HEALTH AND SEWAGE OF TOWNS.

The Reports of the Congresses on the above subjects have been published in pamphlet form, and each report can be obtained at the Society's House, price 2s.

The Council of the Society of Arts are endeavouring to prepare a complete list of all the Reports of Medical Officers of Health which contain references to water supply. They will be much obliged if Medical Officers will communicate the dates of such reports, and, if convenient, send copies to be preserved in the library.

PROGRAMME OF EXAMINATIONS FOR 1879.

The Programme for 1879 is ready, and can be had on application to the Secretary. The Society's Examinations now comprise the following divisions.

1. Commercial Knowledge.
2. Domestic Economy.
3. Fine Arts applied to Industry.
4. Music.
5. Technology of Arts and Manufactures.
6. Elementary.

A Pamphlet containing Specimen Examination Papers in most of the subjects is published, and may be inspected by intending Candidates in the Libraries of the Institutions in Union with the Society; or copies may be had on application to the Secretary of the Society of Arts, price 6d.

CANTOR LECTURES.

SOME ORIGINAL RESEARCHES ON PUTREFACTIVE CHANGES AND ON THE PRESERVATION OF ANIMAL SUBSTANCES.

By Benjamin Ward Richardson, M.D., LL.D., F.R.S.

LECTURE III.—DELIVERED ON MAY 6TH, 1878.

I arrived, at the close of my last lecture, at a point from which it was possible to study certain facts, and expositions of facts, relating to the process of putrefaction in animal structures. With that subject we will, if you please, now proceed. I have already made it, I hope, perfectly clear that decomposition may proceed in dead animal structures that are not exposed to atmospheric oxygen. I have showed specimens of decomposing organic substances in atmospheres containing no oxygen whatever. I show now another specimen which gives the same results in a different way. A portion of beef removed from the carcase immediately after the animal that yielded it was killed, has been placed in the preserving jar, and instantly surrounded by melted paraffin. It was incased so completely in the paraffin, that when the paraffin had solidified by cooling, it formed around the enclosed structure a coating as firm as the glass in which the whole was enclosed. While the paraffin was soft, the stopper of the bottle was also inserted, and the bottle was perfectly sealed. The bottle so sealed was placed in a cold air chamber, with another bottle containing another similar portion of flesh, surrounded simply by the common air, the stopper of the bottle being inserted. The result is that, after ten days, the specimen in paraffin is decomposed, and the gases of decomposition are forcing their way through a small rent they have made in the hard substance surrounding them. They have lifted out the stopper a little, and they give forth the usually offensive odour. The specimen in the air bottle, however, is not decomposed. The explanation of the difference is that the specimen in air has been preserved by the cold, which was able to act upon it, while the specimen in paraffin, owing to the non-conducting power of the paraffin, has not been subjected to cold. The specimen in paraffin, therefore, is not preserved; but we can-

not say that its decomposition has been due to the action of the air, for it has not been exposed to air. To what, then, is the decomposition due?

My answer to that question is, that the first step in the process of the decomposition was the decomposition of the water in the material—or, rather, of a portion of the water in it—into its elementary parts, and that the oxygen in the nascent state, and the hydrogen in the nascent state, then began to combine with the other elements in the structure, to produce new combinations, and to set up the mode of resolution called decomposition.

It may be fair, perhaps, to say that this is not purely a case of oxidation if the decomposition be brought about as I have suggested, by the combinations of hydrogen with the other elements as well as by the combinations of oxygen. This is true; we might as well speak of the change as a process of hydrogenation as of oxygenation.

If the question be asked, and it is a very proper question to be asked, why the water of an organic substance should break up in dead matter and remain intact in living tissue, the answer is that between the living and the dead matter there are differences in mode of change which make all the difference in respect to result. In living matter there is going on a process of resolution, physical and chemical, similar, in all probability, to what is going on in dead matter; but there is this great distinction, that in the living matter there is also going on at all times a process of reconstruction in the same organisation by which the resolution into the final compounds of decomposition is prevented. In dead matter there is resolution, physical and chemical, of the substance without any reconstruction, and with, as a consequence, a diffusion of the newly found products into space.

The study of the process of decomposition of dead matter is, therefore, simpler than the study of decomposition and recomposition in living matter. We can follow the decomposition of dead matter physically and chemically. We can learn very precisely the physical conditions which favour decomposition, and we can follow up the chemical changes which are produced in the various steps of the process. We may consider these points a little further at this stage of our process.

All substances which undergo putrefactive change, in the well known acceptation of that term, are colloidal substances, and are of complex composition. They contain several elements, carbon, hydrogen, nitrogen, oxygen, phosphorus, sulphur and iron entering into some of them. In what form these elements combine is as yet but imperfectly known. The combinations cannot be very firmly knitted together, for they are easily broken up, and a change of arrangement in combination being once established rapidly goes on until the whole of the structure is involved in it. As natural undecomposed structures, they are richly charged with water, and, indeed, are made up in volume of so much water that the uninitiated in the subject can scarcely appreciate the whole truth when it is first detailed.

In order to illustrate how great a part water plays in the ordinary animal foods on which we subsist, and which foods we wish specially to preserve, I have placed on the walls of the room a series of tables from the analyses of M. C. Mène, published about four years ago. This chemist took his specimens for analysis from the Paris markets in the years 1873 and 1874. He separated the bones from the flesh, divided the flesh into parts of equal weight, and then, by two methods of chemical research, made a determination of the proximate and of the elementary com-

TABLES FROM C. MENE'S ANALYSIS OF ANIMAL FOODS.

Table I.—Beef.

Elementary Principles.	Water.	Fatty matters.	Salts.	Albuminous matters.	Nerves, tendons, fibres, &c.	Gelatinous (loss.)	Phosphoric acid in ash.	Nitrogen.	Carbon.	Hydrogen.	Salts.	Oxygen (loss).
Neck (collar)	70·350	6·860	1·410	2·069	13·518	5·793	0·373	4·305	22·164	8·103	1·410	64·018
Side (loin)	68·500	6·353	1·012	3·167	13·209	7·759	..	2·307	25·788	7·895	1·012	62·930
Leg (bottom)	70·900	4·105	0·780	3·050	15·217	5·948	0·220	4·441	23·174	8·097	0·780	63·508
Fillet	71·200	9·860	0·750	2·013	11·465	4·712	..	3·515	22·565	8·150	0·750	65·023
Kidney	69·890	1·283	1·215	3·060	18·105	6·447	..	2·623	25·621	7·528	1·212	63·113
Tongue	68·680	7·079	0·983	2·450	16·530	9·278	0·250	2·185	25·774	7·685	0·933	63·423
Shoulder	70·830	3·083	1·453	3·086	12·215	6·333	0·425	4·415	21·319	8·295	1·453	64·518
Top of back	74·600	5·423	0·925	2·505	13·538	3·009	0·330	3·060	23·819	8·377	0·925	66·819
Between the ribs	72·100	6·406	0·955	4·729	10·100	5·710	0·287	3·352	22·468	8·122	0·955	65·103
Shoulder blade	75·285	6·150	1·128	3·012	10·275	4·150	0·425	3·180	20·689	8·375	1·128	66·828
Cheek	75·280	3·508	1·038	2·590	15·614	1·970	0·295	4·180	18·217	8·485	1·038	68·080
Shin	68·910	4·160	0·900	4·048	3·532	8·450	0·300	5·108	22·472	8·017	0·900	63·503
Sirloin	70·250	3·850	2·020	5·108	12·347	6·425	0·313	2·460	24·661	7·717	2·020	63·142
Rump	72·500	5·160	1·013	3·650	10·497	7·108	0·195	3·550	19·132	8·425	1·013	68·080
Breast	72·100	7·460	0·792	4·113	10·600	4·935	..	4·287	22·340	8·062	0·792	64·519
Steak	71·200	3·100	1·510	3·700	12·410	8·080	..	6·106	19·612	8·355	1·510	64·417
False fillet	71·400	9·600	2·006	2·715	8·179	6·100	0·210	4·515	21·741	8·213	2·006	63·525
False shin	70·515	5·300	1·712	6·990	9·640	5·840	0·300	6·472	20·249	8·048	1·712	63·519
Tail	60·175	3·280	0·878	1·400	21·752	15·515	..	2·155	23·790	8·115	0·878	65·072
Heart	68·755	2·300	0·572	2·415	17·100	8·853	0·195	4·978	23·560	8·013	0·572	62·877
Brains	77·950	8·150	6·780	0·990	4·530	1·600	1·023	1·725	11·303	9·785	6·780	70·405
Lights	83·100	2·740	0·685	3·750	6·140	5·985	0·117	3·333	19·341	8·513	6·780	68·128
Liver	72·960	5·150	1·135	3·500	15·300	1·955	0·370	3·015	21·631	8·219	1·135	66·000
Marrow	3·468	92·526	2·680	0·135	0·519	0·672	0·034	0·055	69·172	11·680	2·680	16·413

Table II.—Veal.

Elementary Principles.	Water.	Fatty matters.	Salts.	Albuminous matters.	Nerves, tendons, fibres, &c.	Gelatinous (loss).	Phosphoric acid in ash.	Nitrogen.	Carbon.	Hydrogen.	Salts.	Oxygen (loss).
Breast	69·660	7·420	1·775	1·525	6·495	14·125	0·100	2·300	22·696	7·984	1·775	65·245
Neck	75·215	6·185	1·075	1·492	2·200	12·833	0·070	2·300	21·100	8·470	1·075	67·055
Kidney (piece)	76·250	7·119	1·250	1·549	1·815	12·017	0·110	2·860	22·150	8·500	1·508	64·982
Kidney	72·850	3·767	1·250	0·912	7·500	13·721	0·009	3·740	20·394	8·503	1·250	66·113
Cutlet	72·660	5·116	1·665	1·333	6·716	12·520	0·065	2·520	22·516	8·079	1·655	65·230
Fillet	72·500	2·683	1·540	2·026	8·145	13·106	0·117	3·120	22·755	8·066	1·540	64·619
Shoulder	76·570	3·621	1·710	2·007	3·088	13·004	0·115	2·920	20·366	8·576	1·710	66·423
Head	85·445	7·243	1·092	0·500	1·240	5·470	..	0·970	18·920	5·098	1·092	74·920

Table III.—Mutton.

Elementary Principles.	Water.	Fatty matters.	Salts.	Albuminous matters.	Nerves, tendons, fibres, &c.	Gelatinous (loss.)	Phosphoric acid in ash.	Nitrogen.	Carbon.	Hydrogen.	Salts.	Oxygen (loss).
Leg	75·500	8·765	3·825	10·283	0·155	1·472	0·065	1·680	28·836	8·827	1·472	59·285
Shoulder	75·700	9·026	4·138	9·746	0·135	1·255	0·078	1·895	27·817	9·033	1·225	60·000
Chop	75·502	8·553	3·537	10·503	0·285	1·620	0·180	1·692	27·311	9·485	1·620	59·892
Neck	74·528	8·515	3·250	11·542	0·590	1·575	0·090	1·575	28·508	9·513	1·318	59·086

Table IV.—Pork.

Elementary Principles.	Water.	Fatty matters.	Salts.	Albuminous matters.	Nerves, tendons, fibres, &c.	Gelatinous (loss).	Phosphoric acid in ash.	Nitrogen.	Carbon.	Hydrogen.	Ash.	Oxygen (loss).
Kidney	74·200	6·690	0·972	2·900	7·150	8·118	..	2·303	33·150	8·090	0·972	55·385
Fillet	73·150	8·425	1·100	2·125	6·000	9·200	..	2·520	34·680	8·258	1·100	53·542
Chop	73·000	8·650	0·955	2·080	10·460	4·855	..	2·160	32·575	8·005	0·955	56·303
Ham	69·600	8·285	1·140	3·800	7·100	13·075	..	3·140	34·100	8·100	1·140	53·520
Knuckle of ham	69·320	5·108	1·097	3·770	7·150	13·555	..	3·700	34·188	8·117	1·097	52·896
Ribs	74·110	7·155	0·905	3·008	12·800	11·932	..	2·855	32·090	7·998	0·985	56·080

Table V.—Salted Pork.

Elementary Principles.	Water.	Fatty matters.	Salts.	Albuminous matters.	Nerves, tendons, fibres, &c.	Gelatinous (loss).	Phosphoric acid in ash.	Nitrogen.	Carbon.	Hydrogen.	Ash.	Oxygen (loss).
Salted ham	62·580	8·682	6·417	8·585	11·210	2·526	..	4·263	37·372	7·025	6·417	44·923
Smoked ham	59·725	8·110	7·082	9·163	12·615	3·304	..	4·310	37·752	6·897	7·082	43·959
Lard	9·150	75·753	5·982	1·125	7·280	0·710	..	1·777	61·250	10·100	5·382	20·891
Sausage meat	65·370	12·180	2·168	2·150	11·172	6·960	..	2·068	39·950	9·350	16·168	46·464
Tongue	69·750	8·217	3·042	2·090	4·350	12·551	..	2·575	35·470	7·200	3·042	51·533

position of each part. The results he arrived at are of value for our present purpose, as showing the component parts of the substances which are under consideration. They are also of value in a purely commercial sense, as showing what are the least watery, and therefore most serviceable, and what are the most watery, and therefore least serviceable or economical animal foods.

You will observe from these tables that the amount of water in beef ranges at from 60 to 75 per cent., while the lungs or lights contain no less than 83 per cent of water. Proportions somewhat similar you will find to hold good in the case of the other kinds of flesh, veal, mutton, and pork. In round numbers you may calculate that the proportion of water in these colloidal

textures is 70 per cent. The blood is not much richer in water than some muscles which feel so solid to the touch, for the blood contains but 79 parts of water, limpid as it flows.

As we glance at this composition of the easily putrescible compounds, it is less difficult to see why the putrescence is so easy, than it would be if we were told by analyses that the structures were as dense as they would seem to be, from the mere act of feeling them in their solid state. We grasp the biceps muscle of the arm of a strong man at the time when he has set it firmly in contraction, and we imagine what a solid mass it must be. We say it is like iron, and so it is to the sense of touch. Yet three parts out of four of that firm muscular mass consist of water.

In a portion of muscular substance that is decomposing in the open air, much of the water is going off by evaporation, in the form of vapour of water, and is carrying with it the products of decomposition. In a portion of muscular substance which is decomposing in a confined space, locked up in hard paraffin for example, the water is retained in the meshes of the spongy organic mass, and some of the gases of decomposition are condensed in it. In both cases a portion of the water has been decomposed, and its gases have entered into combination with the other elements. The oxygen has combined with carbon, yielding carbonic acid, the hydrogen with sulphur, yielding sulphuretted hydrogen, and in some cases with phosphorus, yielding phosphuretted hydrogen. The hydrogen has also combined with the nitrogen, forming ammonia, and with the ammonia some oxidised sulphur compounds have combined, yielding a more complex body, a sulphide of ammonium. These bodies, as they have been produced, are evolved in the gaseous form, and are the causes of the odour which spread from the putrefying substance.

If we enclose a portion of decomposable colloidal substance in a large bottle, and arrange, with such an apparatus as is here before us, to catch the products of decomposition as they are given off, we find that the first gas evolved is hydrogen. Then follows ammonia, and with the ammonia we get that alkaline condition of the tissue which, as I have already said, indicates commencing decomposition.

The water in which the organic decomposable colloidal matters is diffused prior to decomposition holds those matters in one of two states, the aqueous or the pectous; in other and simpler terms, in the fluid states, and the clotted, congealed, or coagulated states; or, in simpler terms still, in the soluble and the insoluble states. In the fresh egg, and in the serum of blood, the colloidal substance is in its aqueous fluid or soluble form; in the boiled egg, and in the clot of blood, the same substance is in the pectous, coagulated, or insoluble form. The difference between the two states lies in their relationship to water. In the aqueous form, the water is so equally diffused, and so completely diffused through the colloidal substance, the whole is as one and the same fluid. In the pectous form, the water has undergone a change in relation to the colloidal substance, by which it is, to a considerable extent, separated from it; under this condition the colloidal substance, as a rule, contracts, and out of its meshes squeezes the liquid part, until it floats alone in the exuded liquid which, unless some new change occurs, has no longer any power to re-dissolve it.

If by any means we can fix the water of the colloidal matter while the aqueous condition of it is present, we hold the colloid still fluid. If we fix the water to the soluble colloid, by the addition of some soluble salts, we prevent the pectous change. Here is some blood which has never been allowed to congeal or become pectous. It pours out of the vessel containing it as freely as when it poured out of the vessels of the animal that yielded it. It has been kept from coagulating by the addition to it, while it was yet fluid, of a certain portion of nitrate of potassa. The salt has fixed the water, so that the communion between the colloid and its water remains. The salt acts as an intermediatory between the two substances, and it has held this position for some months. For all that time it has also held the blood fresh as well as fluid; it has stopped the pectous change, and it has stopped decomposition. Let me, by the simplest of experiments, change this intermediatory position of the salt of potassa. Let me simply add more water to the blood containing the salt, cause the salt to diffuse over a wider surface, and so separate the water from the colloidal substance by the diffusion. I have done this, and we now have merely to wait until the diffusion has taken place. You see the result. The colloidal matter, the fibrine of the blood, which a short time ago was completely hydrated or charged with water, so that it was quite fluid, is separating into a congealed mass or coagulum, from which, by the contraction, watery fluid or serum will exude. The blood will hereupon commence to decompose.

My object in showing this experiment is to illustrate what is a general rule, namely, that agents, which, on being added to fluid colloidal matter, are capable of preventing such colloidal matter from becoming pectous and insoluble, prevent also decomposition. If, instead of treating the blood when it was originally drawn, with the salt, I had subjected it to cold below 35 degrees of Fahrenheit's scale, it would not have coagulated and would not have decomposed; the cold, that is to say, would have acted precisely as the salt has acted; it would have held the water in such a condition that it would not have separated from the colloid, and it would have prevented decomposition. If, instead of cold, I had used pressure for the same purpose, the results would have been the same.

The prevention of coagulation and the prevention of putrefaction go in this manner side by side, because they depend for their manifestation on the same conditions. So long as a colloidal substance is kept fully hydrated or charged with water it does not coagulate, but remains in the aqueous or soluble state. So long as a colloidal substance, thoroughly hydrated, holds its water intact it does not decompose. Break these connections so that the water may physically separate from the colloid, and the particles of colloidal substances begin to coalesce and form a coagulum. Break up the water, so that its elementary parts are separated, and the process of decomposition is established.

If, instead of using a salt, or cold, or pressure, we employ another method of treating the water that is in combination with the aqueous colloid,

we can obtain the same results if we can gain sufficient time for the performing of the experiment. If we take the aqueous colloid and very gently dry it down, so as to remove all the water, the colloid, left dry or desiccated, is found to remain for any length of time without undergoing further change. You may expose it to the air as much as you like, and as long as you like, if you will only let the air be dry, and you will have no decomposition and no change. Here is a bottle filled with dried pulverised albumen which, in its aqueous state, would have become quickly coagulated on the application of heat, and which soon, as you know, would have undergone putrefaction. It is here quite fresh and inodorous. If I add water to it, it becomes quickly hydrated to any extent because it has never gone through the process of coagulation; if I apply heat to it, after such solution, it will coagulate; and if I leave it in contact with water, it will decompose; the water will break up, and the process of putrefactive change will commence. Those old experiments for preserving animal bodies by slow drying in the sun or in heated sand, were examples of the process of preservation by drying.

We can, in some measure, produce preservative results by a reverse method of experiment. If to a thick solution of a colloid, say of albumen, I add an excess of some base or salt, as potassa or salt of potassa, I extract the water from the colloid and fix it too determinately with the salt. The effect is now to produce instant coagulation of the colloid, and such quick removal of water from it, that it is condensed into hardness as if it had been desiccated. Dead bodies embalmed by the chloride of zinc process are preserved in this manner.

I have seen a portion of animal flesh preserved by injection of a saline substance that was very greedy for water, and brought to such hardness by the process, that it felt almost like stone or marble. Each portion of animal structure was practically desiccated by the salt.

Heat applied through water or steam, or directly, has the effect of turning the colloidal structures into the pectous state. We see this in the boiling of an egg. In this state, if the substance that has been subjected to heat be kept so that it can absorb no moisture, and no products from the air, it will remain free of decomposition. Its own power of exciting decomposition in itself has been destroyed by the process to which it has been exposed.

I have said that a colloidal substance which has undergone the pectous change is insoluble. It is so in the ordinary sense, for it will not redissolve in water. It can, however, be made to redissolve in an artificial way. If we subject it to certain bodies, called commonly solvents, agents which diffuse eagerly through water, the colloidal particles may again become hydrated and assume the aqueous form. I have performed an experiment in a flask on the table showing this fact. I placed in the flask a portion of pure white fibrine, and to that I added a solution of ammonia. The flask after this was closed and put away at a 100° F., being often briskly shaken. In a few weeks the fibrine became softened, and by this time, after six weeks of exposure, it is in a state of perfect solution, so that I can pour a portion of it off like a milky fluid. If I add an acid, or apply heat to the milky fluid, it re-coagulates, becomes pectous once again. Agents which possess this power of solution are also preservatives. They fix water.

If a portion of blood which has been allowed to coagulate be put into a strong bottle, firmly closed, and exposed to warmth for some weeks, the blood will decompose, ammonia will be formed as a product of the decomposition, and thereupon the clot of blood will pass again into the aqueous or soluble form. I send round a bottle holding blood that has been re-resolved in the manner described. It is at this time quite fluid, and in it all decomposition has ceased. If I remove this blood from the bottle, many of the products of decomposition that were constructed at first will be evolved with the usual objectionable odour, and there will be a strong ammoniacal odour. These products can be destroyed by passing a current of ozone through the blood; the odour will then pass away and the intermediatory ammonia being decomposed, the colloid of the blood will re-coagulate. The blood will become like unto fresh blood once more.

In living animal structures there is no decomposition or putrefaction in the form of ultimate resolution, because processes of reconstruction are steadily, and at many points, in progress. In the muscular flesh part of the muscle is in the aqueous, part in the pectous condition. The aqueous portion is constantly passing into the pectous, and the pectous is as constantly being resolved into a form of matter, which after the manner of a salt, is removed, and appears ultimately in the saline form as a constituent of the urine, by which means it is eliminated from the body.

The truth which all these experiments teaches is that organic animal structures which are liable, after death, to undergo putrefactive change, pass into that change by a modification in the relationship which they hold to the water by which they are held in the soluble condition. So it follows that those structures which contain most water are most liable to the change. From solid bone to fluid blood there are a series of organs or organic parts which decompose, in order, as they are related to water. If you carry your eye along these tables of M. Mène you will find structures richer than others in water, and these, *cæteris paribus*, according to the amount of water in them, are most rapidly decomposable.

The question which naturally follows upon these evidences is why, in the matter of the dead substances, there should commence a process of decomposition. By what mode is the fixed combination of the elements of the water disturbed? Here is some dried and finely pulverised fibrine of flesh. In this state the powder will remain free from putrefaction for any length of time. I moisten it with distilled water; I leave it so moistened in the same closed bottle, in the air, or even in an atmosphere of a purely negative gas, and if the gas be not readily soluble in water, there will, in a short time, be decomposition with evolution of the hydrogenised compounds in the form of gases. There will be putrefactive change. What has set on foot this chemical and physical decomposition?

I cannot by experiment explain the nature of the change as it has been developed through the water which was added to the fibrine; but I can show you something that helps us in the way towards the explanation. I put into this long narrow-necked bottle a few ounces of solution of

the dioxide of hydrogen. In this dioxide of hydrogen one additional atom of oxygen has been combined with the hydrogen, as compared with what exists in water, and a definite chemical compound has been produced, a compound of hydrogen and oxygen, which is as distinct as is the compound of the same elements in the form of water. To the solution of the dioxide of hydrogen then I add some portion of finely pulverised fibrine, and as soon as this is done there is a brisk commotion in the solution like an active fermentation. There is a gas escaping freely, and when I bring a partly extinguished taper into that gas, the flame of the taper is quickly re-lighted. The gas escaping is oxygen. The presence of the small particles or dust of fibrine has been sufficient to effect a decomposition of the peroxide of hydrogen, and to liberate the additional atom of oxygen, reducing thereby the peroxide back to water.

In another bottle I have some very finely pulverised colouring matter of blood. I add that to the peroxide solution, and at once the decomposition of the peroxide actively commences. The action is more rapid than it was when fibrine was used. In another small vessel I have the colouring substance of blood, the corpuscles of blood, in a fresh state. If I add a few grains of this to the peroxide solution the action is vehement, and lasts until the organic matter is itself decomposed. It is somewhat in a similar manner, but more slowly, that the decomposition of the fresh organic substances are resolved after death. The presence of the fibrine, or of the blood corpuscular matter, is efficient in decomposing the monoxide of hydrogen, water, as we have seen it efficient in decomposing the dioxide; but when the monoxide, that is the water, is decomposed, hydrogen is set free, and in the presence of the nascent hydrogen the decomposition of putrefaction commences as a matter of necessity.

When I had got this view clearly in mind, it occurred to me that perhaps I could either prevent the chemical change of organic decomposition, or delay it, by a process of intermediation of oxygen. If I could make the hydrogen, as it was liberated, re-combine with oxygen, to reproduce water, I could then prevent the combination of the hydrogen with the other elements of the organic body. To test the value of this idea, I placed finely divided muscular flesh in contact with oxygen in various ways; under pressure of oxygen, and in contact with solution of dioxide of hydrogen under pressure. The result you will see in four specimens on the table, two of which have been exposed to oxygen in the way pointed out, and two of which have been left simply—in one case in air, in the other case in water. The evidence is decisive that, in the specimens under the pressure of oxygen, there is arrest of putrefactive change and of production of gases of decomposition. If it were not for the weight of the chambers necessary for resisting pressure of three or four atmospheres, the carcases of animals might be conveyed in a state of preservation from one part of the globe to the other under pressure of oxygen, or of common air. Tropical heat, under such mode of conveyance, would add to the preservation, and the sun would become a preserver.

Before I conclude this lecture, I must briefly notice the physical changes of structure which occur in the course of decomposition. It is not easy to follow them out in the case of simple organic substances, such as albumen or jelly; but in complex structures as, for example, in muscular fibre, it is possible to see some of the changes that are manifested in the break up of organic parts. By means of the microscope we can watch the disintegration of the fibre as the change progresses from stage to stage, and by aid of the oxyhydrogen lamp I can reproduce to you on the screen a precise view of certain of these disintegrations. For this purpose, I will place on the screen four illustrations showing the minute construction of muscular fibre, white and red. In two other specimens I will show the fibre in different stages of decomposition, and in a last specimen I will show a portion of fibre that has been preserved by the action of a salt.

By the first series of these illustrations we see that in the fresh condition the muscular fibre—which is made up ultimately of lines of minute discs of fleshy matter, enclosed in membranous tubes, and separated from each other by a coagulable fluid—is left fixed and firm, owing to the coagulation of the interposing fluid and the extrusion of the watery part through the membranous envelope. By the next series of illustrations, we see that in the first stage of decomposition there is a rupture of the membranous structure, and loss of recognisable arrangement of the muscular fibres, and that in the second stage the destruction is so complete there is left a mere porous, structureless network, the openings of which have been made by the gases that have escaped through the structure. Sometimes you have salted meats brought to table, and as you divide the flesh with the knife you see it to be porous and like a network. Such meat has only been partially preserved, and the porous character of it is due to the escape of gases which have occurred in it during decomposition. The meat is valueless, if it be not injurious, and should not be used as food.

The first note in my next lecture will refer to some external conditions of the air, and of moisture, in relation to putrefactive changes.

MISCELLANEOUS.

MUSICAL EDUCATION.

The following is taken from the *Times* of Tuesday last, the 15th inst. :—

It will be within the remembrance of those who are interested in this subject, that towards the close of the last Session of Parliament, Lord George Hamilton, Vice-President of the Committee of Council on Education, informed the House of Commons that it had been decided to depute Mr. John Hullah to visit the principal towns on the Continent, with the view of ascertaining the methods employed abroad for imparting instruction in music to children in elementary schools. Mr. Hullah is to make a report to her Majesty's Government, who, it would appear, have determined to consider how the present system of musical education may be rendered more efficient in elementary schools.

In this year's annual report of the Committee of Council on Education is a report drawn up by Mr. Hullah upon "Examination in Music of Students of Training Colleges." Mr. Hullah, however, has extended the stated limits of his report, and here and there refers to the condition of musical instruction in elementary schools. He states that he verily believes "the art of singing from notes is now less commonly taught in elementary schools than it was during the years immediately following the impetus given to the subject by the Committee of Council on Education in the year 1841;" and he proceeds to show of how transitory a nature have been the effects of that impetus. He is of opinion that this is due to the fact that the instruction has never being fairly tested either by "being estimated or recorded." Apparently, as a consequence, the practice of teaching singing by "ear" has prevailed, which Mr. Hullah states to be "not only mischievous considered in relation to future musical culture," but "absolutely unnecessary." Singing by ear seems to us to be analogous to teaching children to draw by means of transparent slates. In neither case are the children's better faculties brought into healthy operation. All that is done is to excite into action their lower or imitative faculties. The reasoning faculties are almost entirely neglected.

As long ago as May, 1876, we took occasion to refer to the considerable expenditure of money made by the Government for promoting the musical instruction of elementary school children, and we showed how it amounted to nearly £100,000 per annum—a sufficiently important outlay. We further alluded to the want of a source from which elementary schools could obtain properly qualified and certificated teachers of music.

It cannot be asserted, without possible and probable contradiction from official sources, that the existing method of teaching singing by rote instead of by note is due to the inefficiency of teachers or the incapacity of inspectors to check methods of instruction. From a "musical point of view," Mr. Hullah says it is a "mere sham," and "that it is a costly one is notorious." These are somewhat vigorous utterances for "My Lords" to publish in their own annual report of what they are doing with the funds intrusted to their administration for public benefit. Is it possible that they are not aware of the cost of teaching "singing" under the present system, which their inspector so strongly condemns? Even he seems only just awakened to the fact of the cost, for he says, somewhat timidly, "between £90,000 and £100,000 was, I believe, paid last year" for the maintenance of the pernicious system.

Out of an expenditure of nearly, if not quite, two millions of pounds for education, the amount of one hundred thousand pounds for music—or, more correctly speaking, for "singing"—is not, from a broad point of view, a very great expenditure. It would certainly be small, most likely inadequate, if good results ensued; it is large, and even extravagant, if bad results are obtained. These, possibly, are the considerations which are influencing the desire to make a more fruitful expenditure of public money in promoting musical education.

It is, therefore, a matter for congratulation that "My Lords" have taken a definite step towards ascertaining what systems of elementary musical instruction are in vogue on the Continent; and it is not with any wish to depreciate the projected action of their Lordships that we refer to a volume of evidence taken by a committee of the Society of Arts on the subject of musical education. In that volume, which was published about 11 years ago, will be found statements of experiences and opinions on foreign systems of musical instruction, uttered by musicians such as Sir Michael Costa, the late Sir Sterndale Bennett, Sir Julius Benedict, Mr. George Macfarren, Sir F. Gore Onseley, Herr Ernst Pauer, Herr Otto Goldschmidt, besides a number of valuable documents supplied through our own Foreign-office by different foreign Governments. This publication, in conjunction with Mr. Hullah's forthcoming report, should furnish the authorities at Whitehall with all the fulness of information which the official evolution of some new scheme seems to demand.

In connection with this new Governmental scheme, we may slightly touch upon a proposed "Royal and National College of Music." At present, so far as we can gather from the outlines of the scheme which have been printed and circulated for consideration, this new college aims at being the rallying point of musical cultivation throughout the country. The Royal Academy of Music and the National Training School of Music are to be united. Additional confidence in the scheme will, it is thought, be given by the representation on the council of the "professional element." The college contemplates the bestowal of "Musical Fellowships," as well as the issue of "Certificates of proficiency." Its courses of instruction are "above all" to provide "musical instruction of the highest class." In the face of the development of any new Governmental scheme for musical instruction, which, if it means anything, surely implies the creation of a demand for properly trained teachers of elementary music, it is a little surprising to find that the new Royal and National College does not seem to have considered the national benefit it could probably confer by establishing courses of instruction for teachers of music in elementary schools. We mention this point, and hope it may receive consideration from the influential body who are working to establish the new College of Music. It is not a new idea. Indeed, it is one which appears to have been held by the founders of the National Training School for Music. In a paper read in March last before the Society of Arts, by Mr. Alan Cole, that school is to be, among other things, "the centre whence may be drawn a large proportion of the teachers to whom the country must look for the instruction of its young."

It is, perhaps, too soon to expect distinct signs on the part of the National Training School for Music that it has effected a realisation of this object of its establishment. On Wednesday, however, a semi-public performance by the students of the school is to be given at the Mansion-house. It remains to be seen how far that performance will increase public confidence in the school, which is peculiarly fortunate in being the offspring of public confidence, rather than of pecuniary speculation. All its scholars are holders of publicly established scholarships, of which the Metropolis, the City, the Corporation, and the City companies contribute at least 42. The continuance of this public confidence seems to us to be dependent upon the proof that the instruction given by the Training School is of national utility; and we venture to speak of the school as a foremost element in the new Royal and National College, to prove to the Committee of Council on Education and to School Boards its competency to co-operate with them in their endeavour to improve musical education in this country.

MINERAL RESOURCES AT CONSTANTINOPLE.

The district of Constantinople, says Vice-Consul Wrench, abounds with mineral wealth. The copper mine of Sari-Yeri, on the European side of the Upper Bosphorus, 15 minutes' walk from the place of shipment, is the nearest mine to the city, and it affords a striking instance of the danger to European capitalists of embarking in mining enterprises in Turkey. It was formerly worked by native owners, in a rude and primitive manner, owing to which it produced no profit, and was finally abandoned. So great is the positive discouragement, not to say hostility, manifested by the Turkish Government to mining enterprise, that none but the most venturesome and persistent will venture to

cope with the almost insurmountable obstructions, and the vexatious and protracted formalities, placed in the way of all who attempt honestly to turn the mineral resources of Turkey to account. Nevertheless, it is but fair to add that a set of Levantine speculators exist, whose only object in life seems to be to encourage, by their intrigues, the Government in its determination to allow no foreign subject to work a mine in Turkey.

Thus, although, even in the vicinity of the Bosphorus, there are many indications of the presence of copper, silver, lead, iron, and manganese, no one has ventured to disturb them. Fire clay, china clay, Portland cement stone, alum stone, gypsum, red and yellow ochres, as well as lignite of fair quality, also exist near Constantinople, but their existence is known to but few, and they have been almost wholly neglected. The only local productions from beneath the surface of the ground consist of bricks and tiles of superior make, some lime and quarry stones, but even here the quantity produced is insufficient to supply the local demand, and, with regard to bricks and tiles, it is found cheaper, or, at all events, more satisfactory, to bring them from Marseilles or Trieste.

Iron ores are especially abundant in the neighbourhood; outcropping of lodes of the red hematite class occur in two of the Prince's Islands, and at Pendik, on the opposite main land; and of the micaceous class, near Mont Alemdagh, and near Beicos on the Upper Bosphorus. Judging from several analyses of the iron ores from different parts within a radius of 150 miles from the city, it appears that they are fairly rich in metal, and in some cases remarkably so, as they contain from 48 to 57 per cent. of metallic iron, and one analysis shows even 63 per cent. They are especially valuable on account of their remarkable freedom from phosphorus and sulphur. In fact, the reports of analysis made by the eminent Dr. Noad and other scientific authorities, will show that some of the samples of ore did not give the slightest trace of these or of other substances detrimental to the quality of the iron. It is stated upon competent authority that ores of this degree of purity are unknown in other countries, and that it is thus explained why the natives in some parts of Turkey succeed, even with their primitive furnaces, in producing the finest steel and iron. The iron bars made at the Samakow furnaces, in the Balkans, possess a local renown that secures for them double the price of English bar iron at Philippopolis and Tatar Bazardjik, and a similar state of things exists with regard to the cutlery of Cape Baba. In addition to producing better metal, on account of the absence of sulphur and phosphorus, the Turkish iron ores possess the advantage of not requiring calciuation previous to reduction, or puddling subsequent thereto.

Recent explorations have resulted in the discovery of extensive coal-fields to the westward of Heraclea, towards the River Sakaria, and also to the eastward of Amassera, towards Ineboli. A few years ago the late Sultan, by an Imperial edict, appropriated as an appanage of the Civil List, all coal mines existing, or to be discovered, between the entrance of the Bosphorus and Sinope—a length of nearly 400 miles—to a distance of thirty miles inland from the sea coast. At that time the only coal mines known were those worked by the Admiralty, on account of the Civil List, situated between Heraclea and Amassera. The whole benefit, therefore, of these recent discoveries accrued to the Civil List, and private enterprise was debarred from all hope of obtaining concessions, except by the personal favour of the Sovereign. The discoverers were even precluded from enjoying the limited rights to which they should have been entitled under the mining regulations. A concession over an area of about 3,000 acres, near Ineboli, was, however, conferred by the Sultan on his personal friend, Serkis Bey, the architect of the Palace, and a further Imperial grant in the same district was subsequently made to the Azizieh Steam Navigation Company, of which the Civil List was sole shareholder.

Serkis Bey has commenced preliminary works at his mine, and is constructing a tramway to the coast. It is confidently stated, by persons of thorough practical experience, that an out-put of 200,000 tons of coal per annum can be obtained, although to accommodate the shipment of so large a quantity on the exposed coast of the Black Sea it will be necessary to construct an harbour at an expense of some £80,000. Some of the coal extracted has been practically tested, and the results reported are most satisfactory; it is said to be equal to the best descriptions of English and Welsh coal; nothing, however, worth mentioning has come to market. Beyond the eastern boundary of the Imperial coal fields coal has beeen recently discovered, commencing from near the port of Unié and extending twenty miles inland. The coal has a great resemblance to Cardiff, but in one place anthracite of exceptional quality has been found. The value of the discovery is further augmented by the proved existence of powerful lodes of hematite iron in the neighbourhood of the coal, and by the fact that practicable roads lead to the sea coast. Here also, as in many other of the mines of Turkey, the lodes crop out from the sides of hills, consequently the winning of the coal and iron, and the draining of the mines, are rendered easy and inexpensive, for deep shafts and costly pumping machinery may be dispensed with. Vice-Consul Wrench remarks, in conclusion, that with every advantage of climate, of soil, of material productions of the most varied kinds of geographical position—with virgin forests and with abundant mineral wealth—Turkey would, under an enlightened Government, bid fair to rival half the world in productive wealth.

CORRESPONDENCE.

RE GAS AND ELECTRIC LIGHTS.

Permit me to point out what appears to be an erroneous mode of approaching a consideration of the probable future of these two lights. Nor is it peculiar to these. Men seem so accustomed to estimate relative merit upon a money scale only, that even the first germ of a novelty is met with the inquiry—What does it cost? We all know that there are many articles of daily consumption which, when first produced, cost nearly the same weight in gold as they now do in copper. Lace, for instance, which can be bought for one penny a foot, has been as high as a guinea. I have a box of lucifer matches which cost eighteen pence, and now three such boxes can be bought for one penny.

Now, with regard to the cost of electric illumination, once let it be shown how to divide the intense electric light we have into any number of small lights, then scientific ingenuity must employ itself in devising means for a more perfect storage of electricity than those we at present possess; and I have no doubt that both are quite practicable, and will be done. It may cost hundreds or thousands of pounds; this, however, is too small an element to enter into the future of electric lighting, for a view I have frequently expressed during the past forty years will assuredly be realised, viz., the waterfalls of our English rivers and the tidal wave on our coasts can be converted into electricity, and stored, and distributed so as to supply much of, if not quite all, the heat, and light, and power required in England. Thus, given by nature a costless source, it becomes a simply mechanical question how to utilise it, if, when utilised, it can be beneficially employed.

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JOURNAL OF THE SOCIETY OF ARTS.

No. 1,353. Vol. XXVI.

FRIDAY, OCTOBER 25, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

SOME ORIGINAL RESEARCHES ON PUTREFACTIVE CHANGES AND ON THE PRESERVATION OF ANIMAL SUBSTANCES.

By Benjamin Ward Richardson, M.D., LL.D., F.R.S.

Lecture IV.—Delivered on Monday, May 13th, 1878.

I come, in this lecture, to treat of one of the later lines of research, to which I adverted in the opening part of the course. I am about to refer to an extended series of experimental researches, in which the practical value of various modes of preservation were tried, on a scale larger, perhaps, than has ever been tried before. This research extended over four years. During more than half that time, specimens of animal substances were subjected, at home, to processes of preservation under the most decisive tests I could devise; while other specimens were sent on tropical voyages, to return back to England for inspection after the outward journey. In the complete series, not fewer than 4,000 observations were made. To these observations I need not direct attention in detail. It would be wasted time; for, unfortunately, so much was evidence of failure, and so little of success, that the main part of the work, were it all written, would be one continued page of failure. I shall omit all this, except to speak of some special lesson which may spring from it, and I shall confine my teaching to the modicum that is affirmative and, in a certain instructive if not directly practical way, successful.

As a preliminary, let me state a few facts, which are of signal importance in relation to external prevailing conditions on modes of preservation, a topic I just broached in the concluding sentence of the last lecture.

I need hardly say, that moisture is always unfavourable to the processes of preservation, but it is fortunate that we need not take external moisture into account; because, when we have prepared any specimens, we usually seal them up from the air, and we can always so place them that they can be protected from any external damp. It is not so easy to prevent internal moisture, I mean the moisture which comes from the specimen itself, under the influence of warmth, after it has been enclosed. The expansion of this vapour of water in the preserving case, or chamber, is always a source of trouble.

Heat is another and still more serious difficulty. If means be taken to maintain a sufficiently low temperature by the production of cold artificially, the trouble and the expense are so great they become impracticable on a large, and difficult even on a small scale. The most reasonable plan is to incase the specimen in a very cold atmosphere, and then, while the cold is still maintained, to envelope the closed case in a thick non-conducting substance. Thick felt answers the purpose best. I have obtained the most satisfactory results of all by this plan.

Beyond these difficulties, caused by moisture and heat, there is yet another influence more subtle than either, which constantly upsets all our calculations, spoils our most promising prospects, and does not very clearly explain itself as to its mode of operation. This influence I can only suppose to be electrical in its nature. We know, as a matter of common experience, that during thunder storms some organic fluids and solids are prone to rapid change and decomposition, and this I take it is the same when such fluids and solids are in the presence of some good but rather unstable preservatives. So it happens in the course of experiment that the same preservative which will keep a specimen quite fresh during one voyage may fail most signally if it be tried a second or third time. I once sent forty specimens of animal substance to Rio, preserved in a mixture of sulphurous acid and pure oxygen. The specimens returned in so fine a state of preservation that they were perfect for the table, and were eaten with relish. Immediately, another 40 specimens, prepared in precisely the same manner, were submitted to the same voyage, out to Rio and back again. They came back without any leakage or breakage whatever. The specimens were all securely closed in their cases, but every one of them was decomposed. In the course of their homeward journey there had been heavy storms and much electrical disturbance, and in that way only I account for the result. The power of the agent intended for preservation, to prevent decomposition of the water of the organic substances, had not been maintained.

The motion of the vessel which carries specimens across the sea has also a disturbing effect which is not favourable to preservation. Specimens of meats which have been put into strong glass bottles or metal cases, although they may be found free from putrefactive changes after a long voyage, are often so altered in character they would not be of marketable value. They are sometimes rolled into the most singular shapes; they may look as if they had been forcibly wrung into strands like a rope or cable. They may be mechanically deprived of the water they originally held so that they are mere hard masses floating in the fluid that has been expressed from them.

One more difficulty, a difficulty which confronts us in our best efforts, is sudden alteration of temperature in the course of a long voyage. A specimen will bear a steady high temperature, if it be not very extreme—if it be 80° Fahr., for example—better, and longer than in a lower and a fluctuating temperature. The alteration of the tension of the vapour or enclosed gas seems in

some way to alter the condition of the specimen—like to an alteration which would be produced by friction—and with that variation of motion the change which ends in putrefaction is obviously accelerated. The plan I have described of placing a good non-conductor round the case containing the specimen obviates that difficulty to a considerable extent, but not perfectly.

Modes of Research.

These difficulties stated, let me next describe modes of practical research. The principles had in view were always the same, and are now perfectly understandable. They included the efforts—(1). To prevent decomposition of the water in the specimens. (2). To retain the water in the specimens. (3). To retain the natural colour of the specimens.

In order to bring to a practical proof the value of any new preservative, the first apparatus employed was extremely simple. It is here fitted up ready for use. A strong glass globe capable of holding thirty ounces of fluid, and standing on a firm base, is made to receive a measured quantity of freshly drawn sheep's blood. The bottle is fitted with a stopper from which proceeds a small tap, having attached to it a piece of glass tubing, which turns down into a test bottle containing reddened litmus. The test bottle, in its turn, has an escape tube passing into the mouth of a small receiver in a mercurial trough. After the blood has been placed in the glass globe, the preservative substance is introduced, and the whole apparatus is set in a warm chamber, the air of which is raised to 84° Fahr., that having been found to be the common if not the mean temperature of the storage part of a vessel making the tropical voyage that would afterwards be used to test further experimental results.

The time of the commencement of the experiment with blood being noted, the apparatus was let stand, with the stopper of the globe firmly sealed, and with no escape, except through the tap, for any gas or air. Then it was carefully observed when the first escape of gas took place, if there were any other such, and the gas was all collected in the receiver on the mercurial trough, after passing through the test solution. So soon as the escaping gas changed the colour of the test solution, so as to indicate that ammonia was passing over, the experiment was practically concluded. The evidence was rendered that decomposition had commenced, and the value of the preservative for suspending or preventing the decomposition was recorded. At the same time, the colour of the blood was noted, and all changes of colour were recorded as they occurred.

In these experiments of a preliminary kind, blood was used because of the readiness with which it undergoes decomposition, and the excellent manner in which it shows changes of colour. If in any experiment a supposed preservative showed good evidence of preserving power—if three days elapsed before there was indication of the decomposition of water—then the value of the substance was further tested to ascertain its complete value. In a short time I got sufficient practical skill to be able to arrive at an estimate of the worth of the substance after one or two trials.

Presuming that the experiment with the blood turned out satisfactory, the experiment was next carried to muscular flesh. A portion of steak carefully weighed was placed in a strong clear bottle; the preservative was brought into contact with the specimen in the bottle; the bottle was firmly sealed and placed in the warm chamber, with a tube from the stopper proceeding into test bottles, and from thence to a small reservoir, as in the case of the blood.

If, under this line of research, the value of the preservative was confirmed; if it was found that for fourteen days no ammoniacal gas was evolved, then the inquiry was carried a step further. Another piece of fresh properly weighed beef was put into a bottle with the preservative, and the bottle, firmly sealed down, was placed in a different form of testing chamber, so constructed that the air within it could be heated and cooled at pleasure in a very brief space of time. This chamber is here on the platform, and you can see its arrangements. It is a small glass chamber possessing an air-tight lid. It stands over a water bath, and in that water bath is a long coil of metal pipe which proceeds from an outer tube open to the air, and which ends in the chamber. Beneath the water bath is a gas apparatus for heating the water in the bath.

Into this chamber then we place the specimen or the specimens. With them we also place, in the chamber, a neat apparatus which contains a wet and dry bulb thermometer and a good aneroid. Lastly we cover the chamber with a felt jacket, one of the flaps of which lifts up so that we can read the thermometer and barometer at any time without disturbing the specimens.

In making this experiment we begin with a low temperature. We fill the water bath, and thereby surround the metallic coil with cold water, into which ice is thrown. Then from a tap in the lid of the chamber we draw, by means of an aspirator, a current of cold air steadily through the coil, into, and through the chamber. We can in this way easily maintain a temperature of 45° if we wish. The object, however, is to subject the specimen to the strain of great variation of temperature. We, therefore, let the ice melt, and the temperature rise, and, after some time, we light the gas underneath the water bath, and raise the heat of the water until the air drawn into the chamber through the coil reaches 100° Fahr. We maintain this temperature for a time, and again, by putting out the gas, we let it fall suddenly some 50°, or more. We repeat these observations several times, and watch the effect on the specimens. If any of them bear the strain, if the stopper of the bottle containing them remains firm in its place, and if the colour of the specimen is good for twenty-one days, we consider that the result is satisfactory enough to let us remove the specimen and examine it.

If, after all these trials, an affirmative result is obtained, the last trial made is that of the voyage to some tropical region and back again to England. A voyage of twenty-four days and the same back again is considered a fair test. A process of preservation which would bear that test of 48 days would indeed answer all the practical requirements for conveyance of fresh animal food.

Experiments for a Voyage.

The methods adopted for sending out the specimens on the test voyage next call for explanation. As a rule two plans were followed. One consisted in placing the specimens to be preserved in contact with the preservative, in strong glass bottles of the kind I now send round. The bottles are provided with a glass stopper, and each bottle is capable of holding two pounds' weight of animal structure, with free space around. The structure is placed in the bottles as in the specimen shown, supported by a wooden skewer which runs through it.

There were many advantages in using these bottles. The plan enabled me to perform a large number of very good experiments, and to vary the experiments in numerous ways, at a comparatively small expense. The bottles also were easily charged with preservative, and very easily sealed up. As they were all of one precise size, they exhibited results which were readily compared one against the other. Moreover, the bottles enabled me to see some of the changes which were in progress in them, without the necessity of opening them. Lastly, they could easily be cleaned, and made use of a second time.

I had another reason for experimenting with the bottles. It seemed to me that, if I could preserve meats in these bottles, in an experimental way, I should also have introduced a most practical method of importing preserved animal foods into this country. To the poor, it would be an immense advantage to have meat brought to their doors in small portions, neatly preserved, ready to be opened at any time when required, and so arranged that the jar containing the meat could be returned to the seller. It would also be an advantage to persons in better circumstances to have such a supply of animal food at command at all times and seasons. Beyond these advantages there was another, viz., that this mode of preservation would be most convenient to the preserver, who would be able to divide the parts sent over into equal portions, and export those parts only which were serviceable to the consumer.

After the bottles were charged with the food and with the preservative, the stoppers were firmly inserted, tied down with wire, and thoroughly sealed. The jars were then placed one upon another in these long zinc tubes, cased in thick felt. Each tube would hold four bottles separared from each other by a wad of felt. Then the zinc tubes were soldered down, and were packed side by side in a partitioned wooden case as you see there, and, packed in this manner, they were ready either to be placed aside at home in a heated room or to be sent on a voyage. The common plan adopted was to prepare two cases alike, keep one at home, send the other abroad, and compare the results of the one with the other, when the return specimens were brought back for examination.

The plans for introducing the preservative into the glass jars containing the specimen were made as simple and as practical as could be. If a gas was the preservative, the containing bottle, after the specimen was fixed in it, was inverted over a sliding shelf which had a hole in the centre, through which hole the gas was admitted by a tube which could be passed, for the time, into the the bottle. The gas admitted, the tube was withdrawn, the bottle was slided on to the stopper which had been dropped ready for its insertion into the neck of the bottle, in a hollow circle on the shelf; and, finally, the stopper was closed in and secured. In cases where preservative fluids were used, they were quickly poured into the jar before the stopper was put in. In other cases where saline preservatives were employed, the preservative was rubbed into the specimen before the specimen was put into the bottle at all.

In using preservative gases, I found at first not a little difficulty after preparing the gas, in keeping it so as to measure it carefully out, in each experiment, without bringing it into contact with water, which, in the case of all soluble gases, would absorb some gas and so vitiate the result. I tried first to measure the quantity of gas by means of a small gas meter, but that was not satisfactory. At last I constructed the instrument which is before us, and which, though it is still not quite perfect, answers better than any other instrument I have been able to find or make. In constructing a second instrument of the kind, I could render it quite perfect. This instrument is nothing more than a large inverted syringe. The cylinder is of glass, and is graduated into cubic inches and tens of inches. The cylinder is fixed on an iron tripod, and the piston works from below, the handle of the piston coming down between the legs of the tripod. The upper lid or cover of the cylinder has in it an opening, which receives a stopper, and it is also furnished with a side tap. When the cylinder is about to be used the piston is pushed upwards until it comes to the lower face of the cover of the cylinder at the upper part. Either the opening in the cover or the opening from the tap is then connected with the gas that is about to be used, the piston is slowly drawn down, and the quantity of gas required is drawn into the cylinder. This accomplished, the opening in the cover of the cylinder is closed, and the transference of the gas to the specimen can be made at leisure. The transference is conducted by connecting the tap of the cylinder with a tube leading to the jar which contains the specimen that has to be preserved. After the connection is made, the tap is turned open, and by mere pressure of the piston upwards, the precise quantity of gas that may be desired is forced into the preserving jar. In constructing a new gas measuring apparatus of this kind, I should follow the same kind of principle, but I should not invert the cylinder, I should let it fill from the bottom. I should let the piston descend, as in the common syringe, and I should regulate its descent, and thereby the pressure on the gas, by using a screw piston which would be more accurate and steady in its action.

So much for the modes by which the glass jars were charged; I have yet to touch on the plans that were tried for preserving quarters or whole carcases of dead animals intended for food. When the carcase, say of a sheep, was divided into parts, it was placed in one of these light iron cases, which is made to hold fifty-four pounds of meat in quarters or joints. It is a strong iron case with an arched lid, and the lid is made to drop into a shelving groove below the rim of the cylinder. The

lid is dropped into its position, and then, by a half turn round, is made to slip into a bayonet joint, which holds it firmly when required. There is one other arrangement about this larger preserving vessel. It has in it two openings at the top from which two half-inch metal tubes, furnished with closing screw stoppers, stand out at right angles. One of these tubes runs straight into the cylinder, the other, after entering the cylinder, turns and runs nearly to the bottom of the cylinder. The whole case may be compared to a Wolfe's bottle on a large scale.

In using this preserving case the same plan is followed as with the glass bottle, with this difference that, if a gas is to be used as the preservative, the specimens are introduced, the lid is securely closed, and the gas is driven into the closed case through the long descending tube, the shorter tube being for the time left open. When the specimens have thus been left for a sufficient time to the action of the gas, the supplying pipe is disconnected, and the two tubes of the cylinder are closed by the insertion of their closing screws. The lid of the case is finally sealed down by running a layer of cement or solder into the shelving groove.

The case so prepared is surrounded with felt, is dropped into a rough wooden box, and is ready to be placed in the heated chamber, or to be sent on a return voyage. In some instances, after the specimens in the case had been duly subjected to the preservative, I filled up all the interstices between the parts of the animal structure with molten fat, so that the specimens were completely buried in fat which set firmly around them. Afterwards the lid was sealed down in the usual manner. I cannot report that this addition of weight gave any real addition to the security from putrefactive change.

I have yet one other plan to explain, which is more novel than those plans which have been described, and I wish I could say was more perfect. It is one of those plans which promise well in theory, and which are, I believe suggested to test and to correct the temper and endurance of men who follow experimental pursuits. The idea was that, taking advantage of diffusion of vapours of an antiseptic character, I could diffuse them through the arteries of an animal recently dead, and make them, like a preserving breath, penetrate into the minutest structures, and so preserve. I thought at the same time that, by using the store of the vapour in the condensed state of a liquid, I could so arrange the process of evaporation that, when the temperature was high, the diffusion would be intensified, and when the temperature was low, the diffusion would be reduced. In this way, it seemed to me, a self-regulating, I had a most said automatic, plan of preservation would be secured.

In order to put to experiment the value of this idea, I constructed this flask of metal. The flask is capable of holding ten fluid ounces, and it is made after the plan of an exciseman's ink bottle. There is, that is to say, projecting into it, from a central neck, a conical tube. When a fluid, say chloroform, as a ready example, is put into this flask, it will not run out as a fluid in whatever position the flask is held, but in all positions the vapour of chloroform will readily escape, and the rate of the escape of vapour will be governed largely by the external temperature. The flask, then, so constructed, was charged with volatile preservative fluid, and was ready for use.

The next step consisted in applying the flask to the dead carcase, so as to cause diffusion of the vapour through the tissues. To effect this purpose, the carcases of sheep, which had been killed in the ordinary way, were suspended by the hinder quarters, as if they were about to be flayed in the usual system of dressing. Instead of the dressing being done, the abdomen of the dead animal was opened by the butcher, and the whole of the intestines were removed, a tight ligature being first applied, so as to include all the blood vessels which had fed the intestines, and to close them. These vessels tied, an opening an inch long was made into the abdominal aorta, and a metal tube, having two branches standing nearly at right angles from the centre tube, was tied firmly into the aorta by its branches, one branch being directed towards the upper portion or trunk of the carcase, the other towards the hind quarters. The branches securely tied into the blood vessel, the central tube was closely connected with the neck of the flask containing the preservative fluid; the flask was fixed in the cavity of the abdomen; the opening that had been made into the cavity was neatly closed by stitches; the vessels of the neck of the animal were tied, after the head had been removed, and the carcase was left in order that we might observe from it what changes would follow.

The whole process was so simple that an ordinary butcher was able to carry it out with the greatest ease, and in much less time then it took him to "dress" another carcase for the market. You will at once see what was done and what was attempted to be done. That which was done was this:—The vapour escaping from the neck of the flask was so placed in relation to the body of the dead animal that it could diffuse through the whole of the arterial system. The body of the animal stood in the light of a receiver to the retort which held the preservative fluid. As to the rate of diffusion of the vapour of the fluid into the body, that turned on two chief conditions—the boiling point of the fluid itself, and the temperature of the surrounding air. The whole plan promised at first so well, that my expectations as to its perfect success, I admit, were very great. How it answered, and what values may yet be attached to it, will all appear in proper time and place. I am merely giving details of processes at this moment.

One more of these details is all I need trouble you with further. It relates to the mode of keeping observations. These records were in two series; one was a series of minute and special observations, designed for my own future guidance in research; the other was a general record of results, designed as a guide to immediate practical applications. The last named order of observations were reduced to the greatest simplicity, so that any fairly intelligent assistant could take them down permanently without committing any serious mistake. As a rule, however, I supervised every examination, and dictated the facts as they were observed. To secure uniformity, the following printed form was used for recording the facts presented.

Specimen.

Nature of specimen Weight
Preparation
Prepared in on
Destination
Day of preservation
Examination.—Examined in on

Case or Bottle.

Is the case or bottle containing specimen broken or whole?
Is the stopper or cover firm or loosened?
On removing stopper, or cover, does air escape?

Specimen.

Is it acid or alkaline?
What is its colour?
Has any liquid escaped from it into the bottle?
Is it firm or soft when cut?
What is its smell—fresh, tainted, putrid, or chemical?
How long does it bear exposure to the air without change?
When cooked, what is its taste and flavour?
Is it dry or fluid, tender or hard?

To make the work of experiment and observation complete, I had built, temporarilly, at a little distance from town, a large laboratory, and fitted it up with all the requirements to which reference has been made above.

And now, I ought to proceed to a statement of some results of these experiments, but as the hour is nearly gone, I must wait until we meet next time.

MISCELLANEOUS.

THE COMMISSIONERS OF THE EXHIBITION OF 1851.

Tho sixth report of the Commissioners for the Exhibition of 1851 (dated the 29th July) has just been published.

The fifth report was issued in 1867, and in the eleven years that have since passed, many and important changes have occurred, both in the property of the Commissioners, and in the condition of circumstances affecting their action and their position. The Albert-hall has been completed and opened; the experiment of annual international exhibitions has been tried and abandoned; the new Natural History Museum has been commenced—almost completed; the schools for teaching music, cookery, and needlework have been established; the relations between the Commissioners and the Horticultural Society have passed through various phases of controversy, and seem now to be finally concluded, and many alterations have been made as regards the disposal of portions of their property. These are but some of the incidents forming the history of the past ten years at South Kensington, and providing the material for the volume now just issued.

Intimately connected as the Society of Arts has been with the Commission since its origin, and associated as it has been with much of the work referred to in this report, it may not be inappropriate if a rather full summary be given of the matter contained in the Blue-book now issued. The report commences with an account of the changes in the *personnel* of the Commission, including the election of the Prince of Wales as President, on the decease of Lord Derby in 1869. After this is noted the appointment in 1869, of General Scott, as Secretary, in place of Mr. Edgar Bowring, on Mr. Bowring's being elected a Member of Parliament.

The next point referred to is the erection of the building for the Natural History Museum, now approaching completion. The Commissioners refer to the statement in their fifth report that they had sold to the Government the site of the 1862 Exhibition at less than half its value, in order to ensure the preservation of the building, and record with evident regret the fact, that the vote for the building was rejected by Parliament, and the building consequently removed.

The history of the four annual exhibitions of 1871, 1872, 1873, and 1874, is not given at length, reference being made to Sir Henry Cole's special report upon them, but a brief sketch is given, with a summary of the expenses. The total loss incurred was £22,254, the number of visitors in the four years having been 2,755,901. The cost is thus put by Sir H. Cole at twopence per head of the visitors, and he contrasts this with the cost of the British Museum (4s. per visitor) and of the South Kensington Museum (1s. 3d. per visitor).

The report then goes on to notice the various institutions (permanent or temporary) which have been accommodated on the Commissioner's property. In 1874 the east galleries were leased to the Indian Government for the India Museum at a rent of £2,000 a year, a sum sufficient only to pay interest on the cost of erecting the buildings. Part of the south galleries were leased in 1875 to the Commissioners of Works at £1,500 a year. The west galleries were let in 1875 for a private exhibition of pictures; in 1876 they held the Loan Collection of Scientific Apparatus; and in 1877 they were lent for the Caxton Exhibition. Other parts of the galleries have been used for Government examinations, and in one portion of them are stored objects intended for a proposed Colonial Museum. The School of Art Needlework occupies a building erected by the Belgian Government, and purchased by the Commissioners. The rent of this is £218 per annum. The building which the School of Cookery occupies is lent to the school by the Commissioners, who also contributed £500 last year to its funds.

The history of the relations of the Commissioners and the Horticultural Society is given at some length, from the commencement. The following *résumé* may serve to show the view taken by the Commissioners of the whole matter. In the first instance, they granted a lease to the Society from the 1st June, 1861, of about 22 acres of land. They expended on the property £55,000, while the Society expended £60,000, of which £50,000 was raised by debentures. No actual rent was reserved, but it was provided that the receipts from the gardens should be annually ascertained, and should be applied, first, in keeping up the gardens at South Kensington and Chiswick; second, in payment of the interest on the debenture debt; and, third, in payment to the Commissioners of the sum of £2,361 interest on their expenditure. Any surplus was to be divided equally, and the Society was to devote three-fifths of their share to the reduction of the debenture debt. Instead of the usual proviso for re-entry on non-payment of rent, it was stipulated that the Commissioners should recover possession if for five consecutive years the above-named sum was not paid. At the end of the lease the Society was to be allowed to renew for 31 years, or to receive as compensation £15,000, or whatever larger sum, not exceeding £25,000, the debenture debt might amount to. Before 1864 a further outlay of £13,000 was made by the Commissioners, the sum payable as rent being by agreement increased to £2,400.

In 1861, the Society paid for its half-year's rent £1,029. In 1862, it paid to the Commissioners £2,289 rent, and £506 share of suplus profits, and paid £300 of its debenture debt. In 1863, it paid £203 rent, in 1864, nothing; in 1865, £185 rent, and from that year to 1870 nothing. In 1871 the lease would have been forfeited, but by special arrangement the gardens

were made to form part of the exhibition held that year, and the Society, out of a profit of £5,000, was able to pay its rent, £2,400, and thus save its lease for another five years. In 1872 it paid a rent of £1,200 only. In 1873 a meeting of the Society refused to agree to the proposed arrangement with regard to that year's exhibition, and visitors to the exhibition were no longer permitted to enter the gardens. In 1874 and 1875 various proposals were made to the Society, but no result was arrived at. The end of another term of five years was approaching, and the Commissioners were assured that the rent for one year would be paid by the assistance of residents near the gardens, so that the lease might be saved for a further period, after which the Society probably would, every five years, have obtained money to pay the rent and thus have continued in possession of the ground without any advantage to the public till 1892.

The Commissioners thereupon undertook to postpone their right of re-entry from 1876 (when it would have accrued) to 1878, and agreed, if the Society could raise its income to £10,000, to postpone the right altogether. If the Society should fail to do this, the Commissioners were to have immediate right of re-entry, subject to a payment of £7,000, which the Society was authorised to borrow to pay its debts and set its buildings in order. In 1878 it became evident that this could not be done, and the Society offered to give up its lease. It appeared, however, that the Society could not surrender its agreement without the consent of the debenture holders. As these refused to accept from the Commissioners a sum (amounting to about £14,000) equivalent to the present value of half the debenture debt, the lease could not be given up.

In March of the present year the Council of the Society applied for an extension of time and more favourable terms, but the Commissioners, seeing little prospect of improvement, declined to accede to the offer, and therefore the lease of the Society terminates at the end of this year.

The fifth report gave an account of the laying of the first stone of the Albert-hall by her Majesty. The present one relates its opening, and its history to the present time. The Commissioners in the first instance guaranteed £50,000 besides the ground, which is leased to the corporation of the hall for a term of 999 years at 1s. a year. In return for the grant they were assigned 500 seats in the building. The subscriptions amounted to £120,000, and Messrs. Lucas, the builders, in the first instance engaged to accept the difference between the sum thus provided (£170,000 in all) and the amount of their contract (£200,000) in seats. However, on the completion of the building, the Commissioners paid the difference to Messrs. Lucas, and took over the 300 seats which would have been allotted to that firm. This, with their own 500, gave them 800 seats. These seats are placed at the disposal of the corporation, two-sevenths of all profits being paid in return to the Commissioners, this being the proportionate value of the seats compared with that of all the seats available for the public.

During the Exhibitions of 1871, 1873, and 1874, special arrangements for the use of the hall were made between the Commissioners and the Committee or Council of the hall for its use. In 1871, the Commissioners expended a sum of £3,331 on the Royal Albert-hall Choral Society, and granted a loan of £600 to the Orchestral Society. In 1874, an arrangement was made with Messrs. Novello to give a series of concerts in the hall, the seatholders guaranteeing half the risk. The concerts were carried on first nightly, and then twice a-week, until 62 had been given, when it was decided that the experiment was financially unsuccessful, and it was given up. In 1875, the necessity for an endowment fund was beginning to be felt, and a subscription was raised among the seatholders to defray current expenses. In the following year, an Act of Parliament was obtained, giving the seatholders power to rate themselves at a sum not exceeding £2 per seat per annum. The Commissioners' votes are restricted to one vote for each 50 seats held by them as regards this assessment.

Recently, the Commissioners have undertaken to forego their share of the profits from the hall, in return for the use of the picture-gallery and the galleries adjacent to the conservatory, and they have also resolved to pay off a sum of £4,000 owed on capital account by the corporation of the hall. The galleries thus obtained they propose to leave to the Government, as hereafter referred to.

The next portion of the report deals with the National Training School for Music, and the history of its origin is briefly given. Though this history has been frequently referred to in this *Journal*, it may be as well to summarise here what is said in the report. The movement began in 1854, when the Royal Academy of Music addressed a memorial to the Commissioners, praying for a site for a building. A committee was appointed to concur with the directors of the Academy, but no result was arrived at. In 1867 the Academy informed the Commissioners that they had been in communication with the Society of Arts with the object of enlarging the basis of the Academy, and making it a more national institution. The directors asked for a grant of £10,000 for this purpose, and on this being refused, the Commissioners say, "the authorities of the Royal Academy discontinued their correspondence with us." In 1871 the Council of the Society of Arts applied to the Commissioners for a site for the National Training School, and in 1873 they agreed to grant a lease of a site for 99 years, at a rent of £80. On Mr. Freake's erecting the building and presenting the use of it to the school for five years, the Commissioners "agreed to postpone the payment of the ground-rent for the same period." Soon after this Mr. Freake made an absolute gift of the building through the Prince of Wales to the nation. The first stone of the building was laid in 1873, and the school was opened in 1876. In April, 1877, the Committee of Management of the School forwarded to the Commissioners a statement of the history, objects, and condition of the school. They stated that the school was supported by scholarships of £50 and £40; that eighty-two such scholarships were already endorsed for a period of five years, and that this number might soon be expected to reach 100. Finally they showed that 300 scholarships would be required for the proper development of the school, and they asked the Commissioners to grant at once a sufficient endowment for such scholarships, as well as to promise to use their influence with Government to "induce it to extend the application of the Parliamentary grant for musical education to the Training School."

The Commissioners say:—

We did not consider ourselves justified in complying with this request. It appeared to us that the inadequacy of the income of the school to accomplish the wishes of the committee might be remedied if the school were to instruct, in addition to the free scholars, pupils who would pay for their education. We have not learnt that any tangible objection to this course exists. The principle of combining free instruction with instruction on payment is successful with the art classes at South Kensington, and is adopted by the Royal Academy of Music. There is no doubt also that the original projectors of the school intended to avail themselves of this source of income.

In proof of this, a quotation is given from the Report of the Committee of the Society of Arts (1866), to the effect that the academy should be open to the public at large, on payment of adequate fees. The report proceeds:—

From the foregoing extracts, and from other passages of the same report, we also learn that the "National Academy of Music," which it was the wish of the Society of Arts' committee to see established, was to be formed by an enlargement of the basis of action of the existing Royal Academy of Music, and

while we admire the energy which has been displayed in establishing the National Training School as a separate institution, we cannot help regretting that it was not directed in the path pointed out by the committee of the Society of Arts. We think it right to state that it is our settled conviction that the union of the Royal Academy of Music and the National Training School will be the best means of promoting the national development of high musical training. We have therefore heard with satisfaction that an important movement, under the leadership of his Royal Highness the Prince of Wales and his Royal Highness the Prince Christian, has been made to establish a National College of Music on a more permanent and wider basis than any existing institution, and that the union of the Royal Academy and National Training School of Music forms one of the central objects of the movement. We shall be happy to co-operate, as far as our position allows, with those who are thus working in the interests of Music.

The next few pages of the report treat of the Commissioners' dealings with their estate, the financial position of the Commission, and several other points, which may be passed over here. A list of the institutions now located on the estate as originally acquired concludes what may be termed the historical portion of the report, or that part of it, at least, which deals with the past.

The succeeding portion of the report deals with the future action of the Commissioners. The plan they propose for the disposition of the remaining portion of their estate is as follows. They offer to erect, on a site to the north of the Natural History Museum, a building, "to be used for purposes of scientific and technical instruction, to contain laboratories for study and research, a collection of scientific instruments, and a library of works on science." The building, on which £100,000 would be expended, the Commissioners propose to hand over to Government, on condition that Government shall undertake to maintain it. The site finally adopted, as soon as it was decided that the tenure of the gardens by the Horticultural Society should cease at the end of the year, is on the northern boundary of the present "ante-garden," so that the building would extend across the gardens, joining the southern ends of the east and west galleries. This would leave a wide space of ground between the new building and the Natural History Museum, which it is proposed to reserve for a limited period, for a possible extension of the "Science Museum," and then, if it does not appear to be required for such a purpose, to dispose of by sale for private buildings. The Commissioners also propose to lease to the Government the exhibition galleries, and the galleries of the Albert-hall which, as before mentioned, they have acquired in lieu of their share of profits from the hall. The gardens, or rather the portion of the present gardens to the north of the proposed site, which would then be surrounded by buildings on all four sides, it is proposed to hand over to the Government, on condition that they are maintained "wholly or partially as a public park." These proposals were laid before the Treasury in July last, and it is not stated in the report whether or no they are likely to be favourably received.

The lands lying outside of the galleries, between the galleries and the Exhibition and Prince Albert's roads, it has been decided to sell on building leases, the western portion being first disposed of, so that time might "be given for the consideration by the Government of the purchase of the Eastern Annexe ground for the extension of the Indian and Colonial Museums now provisionally located there."

But the Commissioners have also been wishful to assist more directly than by establishing any central institution, the progress of Art and Science in the provinces. It will be remembered that the claims of provincial centres of industry were brought prominently before them by a strong deputation in July, 1877, and though they have felt themselves unable to comply exactly with the wishes of that deputation, they have yet decided to offer some help to local institutions, by establishing scholarships, which might enable students in provincial science classes to complete their studies, either in London or in any of the provincial colleges of science now being founded. The details of the plan for the award of such scholarships are yet undecided. The amount of money available is as yet uncertain, but it is hoped that it may not be less than the sum (£100,000) it is proposed to expend upon the new science building.

AUSTRALIAN TIMBERS.

Not long since a question was seriously raised regarding the alleged scarcity of tanning materials; like the subject of paper materials, the probability of any deficiency in the supply cannot be looked upon in any other than an important light. It would seem not that the natural resources of the world are absolutely failing, but that man is not sufficiently alive to his own interests to discover or develop any new industry, notwithstanding that new discoveries in science are rather the rule now-a-days than the exception. Physical or mechanical science, however, seem to be the most fashionable and to find most devotees, nevertheless, there are fine fields of discovery in natural science, and more particularly in that section bearing on the application of plants; and, moreover, good reasons why those discoveries should be prosecuted are well exemplified by the demands for paper materials, tanning substances, new dyes, caoutchouc or india rubber, and new medicinal products. It is Australia to which attention is naturally directed as a source of many valuable new commercial commodities. Hitherto the long journey from England and the cost of freight has been, perhaps, the only drawback to the more general utilisation of the vast resources of this great colony. In a climate suited in every way for the cultivation, not only of our own British orchard produce, but also of many semi-tropical fruits, it is surprising that such fruits have not before this been imported in quantities to British ports. It is to be hoped, however, that the recent importation of fresh fruits from Australia to the Paris Exhibition will sufficiently prove the capability of such a scheme, and result in a thorough system of traffic in the fruit trade, and, moreover, open fresh fields for the introduction of Australian produce generally.

In a descriptive catalogue of Victorian timbers exhibited in the Industrial and Technological Museum, Melbourne, the value of Australian woods for furniture, building, and other purposes, is exemplified. Considering the very great variety of useful and ornamental woods produced in Australia and Tasmania, it is surprising that some of the best of them, such as the Huon pine (*Dacrydium Franklinii*), the Tasmanian myrtle (*Fagus Cunninghamii*), the musk wood (*Aster argophylla*), the dogwood (*Bedfordia salicina*), and others, are not more used by cabinetmakers in this country. It has always been said that the expense of freight militates against bringing heavy woods from such a distance as Australia, but if too costly to be used in substance for furniture, it would seem that they might be applied as veneers, for it cannot be denied that some of those just enumerated are unique in figure and colour. It is not that these splendid woods are difficult to obtain, or that there is little prospect of a continuous supply, on the contrary, many of the trees are widely distributed, and the woods are to be had in unlimited quantities. Thus, for instance, the so-called Tasmanian myrtle, or, as it is sometimes called, the evergreen beech, occurs over a tolerably wide range in Victoria, and constituting the main forest for many miles on the Mount Baw-Baw ranges. On account of the great diameter of these massive trees, very large planks are obtainable. The wood is used in the colony for cogs of wheels, by millwrights, as well as by cabinet-makers for various articles of furniture. The musk wood tree is often found up to a height of 60 feet, but seldom or never exceeding that height. It is confined to moist umbrageous forest gullies, but is very abundant in those situations. The wood is of a yellowish or brownish colour, beautifully mottled, with a very

pleasant fragrance. It is hard, and suitable for fancy articles of furniture, pianofortes, as well as for turnery purposes.

In the genus *Acacia*, numerous species furnish a variety of ornamental woods. The principal of these are, perhaps, the black wood or light wood (*Acacia melanoxylon*) a large tree, abundant on the rich river flats and in the valleys. The wood is close grained and heavy, and is useful for all purposes where strength and flexibility are required, being largely used by coach-builders in every department of the trade, as well as by coopers, for railway carriages and trucks, and in the better class of agricultural implements. The colour of the wood is a rich reddish brown with dark markings, in some specimens surpassing in appearance even the finer kinds of walnut. The myall wood, now well known for making pipes, is the produce of *Acacia homalophylla*. It is a small tree found in the Mallee Scrub, valued for its fine violet scented dark coloured wood; besides being used for pipes it is also applied to whip handles and small articles of turnery. This species also exudes copious supplies of gum during the summer season.

The common wattle (*Acacia decurrens*) as well as the green wattle, black wattle, and feathery wattle (*A. mollissima*), and the silver wattle (*A. dealbata*) are all valuable, not only for their woods, but for their barks, which contain tannin, and some of which are regularly used by tanners in the colony. The trees grow to a moderate height, but are very abundant in some districts, and the bark can be obtained in almost any quantity. The trees are stripped in September and the two or three months following, and the bark being allowed to dry, is at once in a condition fit for market, a useful gum known as wattle gum is procured from these trees.

So much has been said of late regarding the uses and probable extended application of the products of the *Eucalypti*, that a few notes on the products contained in the Industrial Museum at Melbourne will exemplify the value of this great genus. Of all the species the blue gum (*E. Globulus*) is certainly the best known, on account of its reputation, whether justly so or not is still unproved, of purifying malarious districts. Few trees, perhaps, have ever attracted so much attention as this species. Trees have been planted in almost every country where it could possibly succeed, and even in small private gardens the blue gum is very often to be found. As a timber tree it will no doubt prove valuable, on account of the colossal size to which it grows, and its extremely rapid growth, together with the great strength and durability of the timber, which in the colony is largely used for beams, joists, &c., in buildings, and for railway sleepers, piers, and bridges. Besides the uses of the wood, the resin exudes from the tree in very large quantities. Essential oil and other extracts have also been prepared from the foliage. The most colossal species is, perhaps, *Eucalyptus amygdalina*, which is known locally under various names as stringy bark, messmate, peppermint, &c. It is said to be not uncommonly found up to a height of 420 feet, and sometimes to attain a still greater height. The wood is hard and close-grained, well adapted for house-building, planking of ships, shingles, rails, and other purposes. This species contains more oil in its foliage than any of its congeners; 1,000 lbs. of fresh gathered leaves, with their small branchlets, yield by distillation 500 ounces of oil. It is rubifacient, disinfectant, and employed externally in rheumatic affections, and in perfumery, scenting soaps, &c. The spotted gum of Victoria (*Eucalyptus goniocalyx*) is a species often found of a very large size, but mostly of moderate dimensions. The wood is hard, straight, and even-grained, and is employed in the colony chiefly for joists, beams, rafters, and heavy framing work, as well as by coopers for staves. The bark is described as being usually deciduous, but sometimes persistent. The species produces resin in very large quantities, and from 100 lbs. of fresh leaves 16 oz. of essential oil have been obtained. For illuminating purposes, this oil is admirably adapted; it produces a brilliant white flame, superior in intensity and colour to that from the best American kerosene, and its use in kerosene lamps does not cause any smoke or smell, and is free from danger. The other most useful species valued for their timber are—*Eucalyptus rostrata*, the red gum tree, a tall growing tree, very abundant along the river flats and open valleys, the wood of which is of a brownish red colour, and is used alike for furniture, carpentry, agricultural implements, and ship and house building; *E. leucoxylon*, the iron bark tree, often growing to a great height, and producing, perhaps, the strongest timber of the whole of the eucalypts; and *E. obliqua*, the Victorian stringy bark tree, a gigantic tree, not unfrequently attaining a height of from 300 ft. to 400 ft., with a very thick, rugged, and fibrous bark, hence its local name. The wood of this tree is not so strong and durable as most of the other species. It is straight, and even-grained, and is readily split into fencings, palings, shingles, &c.; nevertheless, it is very liable to warp and twist. The thick fibrous bark is used for thatching houses. The woods here enumerated are but a mere tithe of what may be obtained from the Australian forests, and, bearing in mind that India has recently sent into the English market samples of its native timbers, with a view to establishing a traffic with this country, it is not, perhaps, too much to hope that the time may not be far distant when Australian woods will appear regularly in the timber market.

GENERAL NOTES.

American Petroleum.—The total export of American petroleum from 1861 to and including 1877 (16 years) is given at 442,698,968 dols. custom house valuation. From the best sources of information there are at this time 10,000 oil wells, producing and drilling, which, at a cost of 5,000 dols. per well, would make an investment of 50,000 000 dols. in this branch of the business. Tankage now existing of a capacity of 6,000,000 barrels cost 2,000,000 dols., and 7,000,000 dols. have been invested in about 2 000 miles of pipe line connected with the wells. The entire investment for the existing oil production, including purchase money of territory, is something over 100,000,000 dols., which amount cannot be lessened much, if any, for as wells cease to produce, new ones have been constantly drilled to take their place.

The Coinage in France.—The authorities of the French Mint have just addressed to the Minister of Finance a table of gold and silver coins struck from 1795 up to the end of 1877. The year 1795 was taken as a starting point, because it was in that year money was first manufactured on the decimal system. With regard to the gold coins it is remarked that only 20-franc pieces were struck in 1877. The coinage in that year amounted in value to 255,181,140 francs, or 12,759,059 pieces. The following is the nominal value and number of the gold pieces struck since 1795 classified according to the description of coins:—Pieces of 100 francs, 44,346,400 francs; 50 francs, 46,568,700 francs; 40 francs, 204,434,360 francs; 20 francs, 6,708,899,220 francs; 10 francs, 1,013,641 610 francs; 5 francs, 233,440,130 francs. By adding the value of the 20-franc pieces struck in 1877 we have a total of more than eight and a half milliards (£340,000,000) for the gold coined in France from the indicated starting point. The silver pieces struck in 1877 were only to fulfil orders given to the Mint before the promulgation of the decree of the 6th August, 1876, which suspended the manufacture of 5-franc pieces, these amounted to 16,464,285 francs. No silver money of any other value was struck in 1877. From 1795 to 1876, eight milliards, 510 millions of silver money was struck, of which amount five milliards were in 5-franc pieces; 152 millions in 2-franc pieces; 193 millions in 1-franc pieces; and 89 millions of 50-centimes pieces. The total value of bronze money of 10, 5, 2, and 1 centimes coined since 1795 amounts to the present day to 62,702,785 francs, 40 centimes.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,354. Vol. XXVI.

FRIDAY, NOVEMBER 1, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

NATIONAL TRAINING SCHOOL FOR MUSIC.

The Fishmongers' Company's scholarship of £40 per annum, recently vacated by Miss Lemmon in consequence of ill-health, was on the 28th inst. awarded by Messrs. John Hullah and W. G. Cusins, after a severe and searching examination of two days, and of 25 candidates, to Miss Marian Emily Stewart. Miss Edith Angel Wood, pianist, and Messrs. William James Barton and Henry Collingwood Banks, organists, are very highly commended.

UNION OF INSTITUTIONS.

The following Institution have been received into Union since the last announcement:—

Green Coat Schools, Camberwell, S.E.

CANTOR LECTURES.

SOME ORIGINAL RESEARCHES ON PUTREFACTIVE CHANGES AND ON THE PRESERVATION OF ANIMAL SUBSTANCES.

By Benjamin Ward Richardson, M.D., LL.D., F.R.S.

Lecture V.—Delivered on Monday, May 20th, 1878.

I hope I made myself sufficiently plain in my last lecture in respect to the different methods pursued for conducting a practical inquiry as to the value of different preservatives of animal substances intended for food. It is my duty now to offer, as briefly as is possible, a statement of some of the more important results which came from the inquiry.

Method by Diffusion through the Arteries.

I commence with a reference to the method described in the last lecture of preserving by diffusion of volatile preservative fluids through the arteries of an animal recently dead. You will remember that in carrying out this process a flask specially constructed for holding the fluid that has to be volatised is tied in the abdominal aorta, and from the flask the vapour is allowed to diffuse over the whole of the arterial system, so as to reach the tissues of the body in every part.

This plan was first tried on a small scale, with the carcases of rabbits and hares. It was afterwards tried on the carcases of twelve sheep. The facts relating to these larger experiments are important, and they are sufficient to show the value of the method, as far as I have yet learned its value. I will select from the experiments five of the more striking.

Diffusion of Chloroform Vapour.— In the first of these experiments, one fluid ounce of pure chloroform was placed in the reservoir or flask with three ounces of light paraffin. The paraffin was added to the chloroform in the flask in order to prevent a too rapid evolution of the vapour of chloroform, and was the result of some previous experiments for securing an equal and moderate escape of vapour. The diffusion of the chloroform vapour was detectable quickly through all the tissues of the carcase. The carcase, wrapt in cloth and covered with sawdust, was laid in a wooden case on the 15th of August, and was allowed to remain for 48 days. At the end of this time the structures of the body were all found entirely free of decomposition, the fat of good colour and firm, and the flesh red, but softened in structure, so that it was unfit for food. Two ounces of fluid were left in the reservoir.

Diffusion of Ammonia Vapour.—In the second experiment, in place of chloroform one fluid ounce of solution of ammonia, specific gravity 0·959, was placed in the flask again with three fluid ounces of the light paraffin. The carcase was left in the same manner as in the last experiment, but was examined two days earlier, namely, after having been kept forty-six days. By accident the wooden case in this instance got exposed to wet, so that three inches of water collected in the lower part of the case. For all that the preservation from putrefaction was perfect. The flesh throughout was quite sound, was firm in structure, but too dark in colour. The fatty matter everywhere was firm and natural. The result was not such as to present food fitted for consumption. The flask was nearly empty of fluid.

Diffusion of Sulphurous Acid and Vapour of Carbon Bisulphide.— In a third experiment the process was repeated, in the same manner in every respect, on another carcase of a sheep, with these exceptions. Before fixing the flask into the aorta a current of sulphurous acid gas was gently driven into the arteries with a current of carbonic acid. The flask was next tied in the vessel as before, but was charged with one fluid ounce of bisulphide of carbon and three fluid ounces of paraffin. The carcase was left as before wrapped in cloth and covered in sawdust in a wooden case. It was not touched for forty-six days, and was then examined. The results in this instance were very striking. The carcase was free of all signs of putrefaction and of all odour. The hide was sound and was removed by the butcher readily and cleanlily. The fat in all parts of the animal was natural. One kidney were natural in colour, consistency, and size; the other kidney was shrunken. The liver was a little shrunken, but cut quite firmly. The heart

was natural, but the lungs were shrunken. All the muscular parts, the shoulder, the loin, the hind quarters, were natural and as fresh as when first killed, but slightly grey in colour. The muscular flesh also emitted a faint odour of the bisulphide of carbon.

One leg of this carcase was boiled, the other was roasted, and both were in good condition. The flesh had two faults. There remained in it, even after cooking, a faint odour of the bisulphide, and in parts the flesh was porous from infiltration of the vapour. The flesh kept well for six days, and retained its colour. Dogs fed on it greedily and safely. An ounce and a half of a milky-like fluid was left in the flask.

Diffusion of Sulphurous Acid Gas and Ammonia Vapour.—In a fourth experiment, on another carcase of a sheep, the same plan was followed generally, with a variation only in the vapour diffused. In this instance, before charging the flask, half a cubic foot of sulphurous acid gas was gently forced into the arterial vessels. Then the flask was inserted in the usual way, and was charged with one fluid ounce of solution of ammonia (specific gravity 0·891) and three fluid ounces of light paraffin. I expected in this way to produce a salt in the tissues by the combination of the ammonia with the sulphurous acid. The carcase was left as in the other cases, and was allowed to remain for forty-seven days. It was then submitted to examination.

The result of this experiment was very good. The carcase was perfectly preserved, and was as free of odour of putrefaction as at the first. The hide also was sound. The kidneys were shrunken, but the fat around them was perfectly natural. The heart was preserved, but shrunken, and the lungs were much shrunken. The muscular structures in every part were perfectly preserved, shoulders, loins, saddle, and legs. One fault only distinguished this experiment, the muscular flesh everywhere was too pale.

Mem.—About an ounce of fluid was left in the flask, and on turning it out it was of bright red colour. I thought at first that some retained blood of the animal had got into the flask, but failing to trace any evidence of blood, I mixed ammonia solution and paraffin together, and left them in contact, shaking frequently. In a few weeks the same red colour was produced.

Diffusion of Sulphurous Acid Gas.—In a fifth experiment, performed in respect to mechanical details in a similar way, diffusion of sulphurous acid through the artirial system was tried. After the artery to the abdomen was opened, half a cubic foot of the gas was gently forced by piston pressure over the structures. Then the flask was tied in the usual way, and into the flask there was introduced four fluid ounces of ethylic alcohol saturated with sulphurous acid.

The carcase treated as before was left for forty-seven days. It became like one of the other specimens exposed to wet by an accident, but it, nevertheless, retained its freedom from putrefaction. The hide was quite perfect, and was removed without trouble. The kidneys were shrunken, but the fat surrounding them was firm and natural. The liver was shrunken, but firm; the heart was rather shrunken but fresh, and the lungs were much shrunken. The fleshy parts were quite fresh and natural in all respects except in colour. The red colour which distinguishes the flesh immediately after death was changed to a pink, or, it may almost be said, ashy colour. On exposure to the air the flesh ran more quickly into a putrefactive condition than in the experiment where the bisulphide of carbon was employed. At the same time it was not tainted with the odour of the preservative, and when it was cooked it had no fault at all except the spoiled colour, which was sufficient to destroy its marketable value.

In the other experiments performed in a similar manner, the preservative action of carbolic acid, tetrachloride of carbon, butylic alcohol, and of some other alcohols was tested. The results were not so satisfactory as in the above-recorded instances, and they need not, therefore, be introduced. Reviewing the process of diffusion through the arteries as a whole, I am inclined to think that it admits of being continued, and that, with some improvements, it might be made applicable to the purposes of preservation on a large scale. In further research, it would be desirable to determine more definitely the best vapour or gas, or the best mixture of vapour or gas, that should be diffused. This ascertained, it would next be best to keep the reservoir of gas outside the carcase of the animal, and to govern the diffusion by pressure exerted on the gas or vapour in the reservoir, so as to sustain an exact rate of diffusion into the carcase. In this way, from one reservoir, many carcases, all suspended in a chamber or packed into a case, could be charged. If coal-gas could be made inodorous and tasteless, it could be made an admirable menstruum for conveying one of the more decisive preservatives in this process. The most marked objection to the process is that the flesh, even when it is preserved, is rendered porous in parts. This destroys the natural appearance, and suggests the idea of decomposition. It would possibly be avoided by submitting the structure to less pressure of vapour or gas.

EXPERIMENTS WITH SPECIMENS PRESERVED IN BOTTLES BY VARIOUS PROCESSES.

A considerable number of experiments, in which a test tropical voyage was made part of the inquiry, were conducted on parts of animal structure placed in bottles in contact with the preservative. Mutton and beef were the animal structures almost invariably used, and, as a rule, two pounds weight was the quantity employed, the fat being removed as far as possible. The specimens were, in all cases, mounted in the bottles in the same manner as you have seen in the bottles on the table. The large green-glass jar was the kind of jar found to be best for the purpose; it is strong and cheap, and can be securely stoppered.

In every instance where the specimens went on the return voyage they were not examined until fifty days after they had been placed in their preservative.

I followed up in this, as in previous researches, the method of exposing the structures to the action of gases, selecting those gases which had proved to be most effective in experiments previously carried out at home.

In every case one of two gases was used as the menstruum for carrying the preservative: (*a*) common coal gas; (*b*) coke vapour. The first of

these was very convenient for use, since it was at all times at hand, but in a little time I succeeded in making the coke vapour act very readily in the following simple way:—

A small common stove was used for the combustion of the coke or charcoal in order to produce the vapour. The fumes from the burning coke were conveyed from the stove by means of a two-inch stove pipe, which was made to traverse a tank containing cold water. The heat of the coke vapour was thus reduced, and the end of the pipe, which was four feet in length, slipped into a long metallic trough consisting of half the circle of a ten-inch cylinder. The convex part of this semi-cylindrical trough was turned down and rested in another water trough. The upper part of the half cylinder was closed in by a flat roof, or shelf, which was perforated with holes two and a half inches in diameter, and four inches apart. The semi-circular cylinder was four feet long, and the number of holes in its upper flat surface eight. At the end of the cylinder was an exit tube, by which the fumes were finally carried away into a flue.

You will see here how easily this apparatus works for the purpose we want. The bottles containing the specimens to be preserved, with their stoppers removed, are inverted over the openings in the cylinder. The fumes from the coke fire pass abundantly along the cylinder beneath, and in a few minutes sufficient of the fumes have diffused into the bottles to charge them. Eight bottles can be charging all at one time. When a bottle is ready to be removed, a glass plate is slipped under the mouth of the bottle in the same way as in using the pneumatic trough, and the bottle is slidden away, to be replaced by another which is standing ready. The bottle that has been removed has now only to receive its charge of the preservative, to have its stopper inserted into it, and to be sealed down.

The use of the coke vapour, or of the common coal gas, is twofold. The vapour or gas acts as a menstruum through which the preservative can diffuse, and it preserves the colour of the specimen. Coal gas contains carbonic oxide gas, and the retention of colour is due to the presence of this latter gas. The fact has been told before, but it is better to restate it at this stage of our progress.

For the introduction of coal gas, when that is used instead of coke vapour, the same kind of apparatus may be employed, and, indeed, the half cylinder before us is constructed to act for both. But in the case of its being employed for coal gas a little difference of adaptation is required. The water trough for cooling is now not required. Along the cylinder there runs a half-inch gas tube, and from that at right angles there branches off a short tube opposite to each of the holes, over which the bottles stand. A connecting tube from the gas supply connects the gas with the tube which runs along the cylinder, the tube is closed at the extreme end, and as each jet under the bottles is opened, a little pressure of gas charges each bottle, sufficiently, in one or two minutes.

I have described these processes with care, because they are both convenient under different circumstances. The coal gas is excellent for quick experiments. The coke is best for actual practical work of preservation, and it is so simple that there is no outlandish place in which it cannot be fitted up. Wherever wood can be got from which to make charcoal, and wherever a furnace or stove can be constructed, the coke vapour can be applied. I have exhibited here an iron stove and cylinder because it is at hand, but, as you will see, the same could be constructed out of brick or stone.

To place the preservative in the bottle containing the specimen, and charged with the coal or coke gas, was the next step, and, whenever I could, I used the preservative in a state of solution, introducing it quickly from a graduated syringe tube, and immediately inserting the stopper into the bottle. If the preservative could only be used as a gas, the mouth of the bottle was covered firmly with a wooden plate through which a glass tube could be moved up and down; in the wooden plate there was also another small tube fixed in the wood. The wooden plate placed over the mouth of the bottle and held by a binding band, the required measure of gas was driven into the bottle through the glass tube, which for the moment was pushed to the bottom of the bottle. The gas introduced, the tube was drawn up before the wooden plate was removed; the plate was slidden off to permit the insertion of the stopper, and the bottle was closed and sealed firmly.

And now as to the most successful of results. It would take a good many lectures to recount in detail the unsuccessful. The successful can be told off in the present and next lecture readily. In saying this I do not wish to underrate success. There is much to be recorded that is well worth the trouble of learning, and that is full of promise, as you will see.

The best results were obtained in this series from carbonic acid, nitric oxide, sulphurous acid, ammonia, compressed oxygen, and cyanogen.

Carbonic Acid.—In an atmosphere composed of two parts of coke vapour and one of carbonic acid, six specimens of beef and six of mutton made a tropical voyage and returned back to England. They were examined on the fifty-fourth day of preservation. They were found to be free of taint of putrefaction, and of fair colour, but too soft in structure to be marketable. They commenced to decompose rapidly after exposure to the air.

The same number of specimens in London, in a room the mean temperature of which was 84° F., presented appearances so nearly the same as to require no further comment.

Twelve other specimens in bottles charged with equal parts of coke vapour and of carbonic acid, and sent out a similar voyage, returned free of all trace of putrefactive change, but darkened in colour. The colour was so much darkened that the structure was not passable, and decomposition was soon established after exposure to the air. The same results were obtained in twelve other specimens preserved in the same way, and retained at home in a temperature of 84° F.

A third series of twelve specimens was sent out, in which the preservative atmosphere consisted of three parts of coke vapour and one of carbonic acid. In this case the specimens returned of a natural bright red colour, but in all cases tainted. A corresponding series, treated in a similar manner, was retained at home as before with the same results.

Lastly, a series of twelve specimens was sent on the test voyage, in which coal gas was used as the menstruum and preserver of colour instead of coke vapour. The gases were mixed in the same varying proportions of carbonic acid as in the experiments with the coke vapour, and the results tallied in all respects. In the whole eighty-four observations were made on the action of carbonic acid, and the uniformity of results enables me to place it in its proper position. It stands low in the series of preservative substances, but it does preserve, its preserving power being represented fairly by its solubility in the water of the tissues. It is not practically of service for another reason, namely, that of the discolouration which it produces, and we may herewith dismiss it from our notice. Specimens of animal structure preserved in it, in illustration of the trials of it above related, are on the table, and will answer for themselves if you wish to examine them.

Nitric Oxide.—Some previous experiments with nitric oxide led me to try it on a larger scale. The gas is made by pouring nitric acid over copper wire, or copper filings, in a glass retort. The gas comes over colourless, but at once assumes a beautiful red colour when it enters into contact with oxygen. This was the nitrous gas of Priestley, which he used as a test for the presence of what he called dephlogisticated air, and what the later observers called oxygen. It occurred to me that, in the presence of nitric oxide, decomposition by oxidation was impossible, because any oxygen present would be at once seized by it, and nitric tri-oxide be formed.

In these experiments pure carbonic oxide was used as the menstruum instead of coke vapour or coal. The carbonic oxide was introduced into the jar containing the specimen until the whole of the air was displaced. Afterwards, the nitric oxide was introduced, and the absence of free oxygen proved by the absence of red fumes. The nitric oxide was used in the proportion of one-twelfth, one-eighth, and one fourth part. Seventy-two observations were made; half on specimens subjected to a test voyage, and half on specimens retained for comparison at home at a mean of 84 deg. F. The results in all cases were fairly uniform. The specimens subjected to a fourth, and even to an eighth, of the gas were quite free of putrefactive change, and were, indeed, as free of decomposition as at the time when they were placed in the jar. Removed from the jar, they yielded no red fumes on exposure to the air; a fact indicating that the gas had been transformed into the higher oxide. The colour of the specimens was changed into a rather brownish red, and the structure was rendered extremely firm and condensed. The specimens placed in the twelfth part of nitric oxide were less hardened, but they, too, had assumed a reddish brown colour, and some were slightly tainted, so that I did not see the necessity of trying the effect of the gas in smaller proportions. On the whole, the research showed that nitric oxide, although a preservative, and applicable perhaps for some forms of preservation, is not adapted to the preservation of animal substance intended for food.

Sulphurous Acid.—As might be anticipated from what has already been said, and from the many specimens which have been, and are before us, sulphurous acid has yielded the most singular and valuable results. An atmosphere composed of one-fourth part of the gas, with three parts of coke vapour or of coal gas, or of pure oxygen, or of carbonic oxide, is the most certain preservative of structure and of colour. In trying various quantities of gas and of menstruums, in sending out specimens on test voyages, and in keeping corresponding specimens, at varying temperatures at home, I made over a thousand experiments with sulphurous acid.

The result of these inquiries were so striking, one might argue from them that the problem of preservation of animal structure is actually solved. There is here a specimen of beef which has been in the bottle for ten weeks. It is simply in a mixture of sulphurous acid gas and oxygen, and you would not know that it had been removed from the carcase one hour. It might be cooked, and eaten with relish.

The same kind of result attended many of the specimens which I sent, preserved in a similar way, on the long return voyage. They came back in a perfect state of preservation, they were cooked, and were in excellent condition for food.

What then, it will be asked, is the reason that a process of preservation so simple and effective cannot be at once put into practice. The process is cheap as well as effective, and, really, no troublesome or cumbersome apparatus is required for working it. Neither, again, is great skill required; any intelligent working man may learn how to carry out every detail; and any district that would furnish the meat supply would also furnish the materials for the factory, except the cases or bottles. This is all true, but there are still one or two difficulties which stand in the way of this plan. The first difficulty is that the animal substance, natural as it looks in the bottle, does not retain its good looks after it is removed from the preservative. If you take it out of the gases and place it in the air for an hour, it will, by the end of that time, have changed in colour. It will become pale, and soon the paleness or pinkness will pass into grey. With this the structure will also become moist, and what is vulgarly called "flabby," from rapid absorption of water. Very soon upon this it will begin to decompose. These objections are of themselves fatal to success, as our advance now stands.

There is another objection. When the meat is cooked, however carefully it may be cooked, there is about it a certain flavour which is not natural. There is a slight acidity, and there is a taste like that which belongs to lightly salted animal food; and once more the natural odour of the fresh meat is not retained. These objections are serious, if not decisive.

The third difficulty in this mode of preservation is the accident of decomposition while the food is making the voyage, an accident due to one of those disturbing causes to which I drew attention in a previous lecture. Twice the specimens sent out, treated by the process under consideration, came back in perfect preservation throughout all the series. Once a series sent out, prepared in the same way without a single deviation, came home with every specimen tainted, and with some advanced in decomposition, while specimens of the same series retained at home were completely preserved.

Ammonia Vapour.—You will anticipate from what you have seen already, that the vapour of ammonia answered well in the test voyage experiments. The anticipation is quite correct. Nothing could be more perfect as a mode of mere preservation than the exposure of the animal substances to the vapours of ammonia, in combination either with coke vapour, carbonic oxide, coal gas, or oxygen. The bottled specimens first sent out, so preserved, returned, I may say, as they were sent forth in respect to freshness and freedom from putrefaction, and they remained free of putrefaction for several days after they were exposed to the air. This being the case with the specimens enclosed in bottles, I sent out much larger consignments in metal cases, including in one instance the entire carcase of a sheep, and seventy pounds weight of beef. These all returned perfectly free of putrefactive change, and compared with other similarly prepared specimens which were kept at home for comparison, in the usual way, they were good, equally good in comparison. Let the specimen, in a bottle, which I hand round, and which has been kept in ammonia vapour and coal gas for sixty-four days, convey to you how perfectly free from putrefaction this plan keeps the animal structure. It is unnecessary to enter into further description of detail of this mode of preservation. It is on one side faultless, and on the other side worthless. If we wanted merely to transport animal carcases in a fresh state it would answer all our desires; but as we want to feed on the carcases after they are transported, it is useless to us as it is now applicable. The cause of failure is simple. So soon as sufficient ammonia is introduced to preserve even in the presence of a medium which protects the colour, the colour is a little darkened. This might be tolerated, but there follows another and worse objection; so soon as the ammonia is introduced in sufficient quantity to preserve, it enters into combination with the water of the tissue with such firmness that it cannot be removed. The meat, even when it is laid exposed to the air after its removal from the vapour, and when it has been subjected to every possible form of preparation in cooking, retains the taste of ammonia, and is thereby rendered inadmissible to the table as food. At a temperature of 60° Fahr. one volume of the water of the tissues takes up 680 times its volume of ammonia. The fact explains why the ammonia is so good a preserver; it explains, at the same time, why the preserver is so hard to remove from what it preserves.

Hydric Chloride.—The gas known now as hydric chloride, and which, when it has become diluted and dissolved in water, forms the fluid known as spirit of salts, or hydrochloric acid, was tested as an intermediate between ammonia and sulphurous acid gas. The water of the tissues takes up at 60° Fahr. 37 volumes of sulphurous acid gas (or more correctly speaking hydric sulphite). The water of the tissues takes up at the same temperature 390 volumes of hydric chloride. It was certain, from its readiness to combine with water, that hydric chloride would preserve; the question was what change would it produce on the structure subjected to it. This gas had been omitted in the earlier researches, and experiments with it were, therefore, new.

Twelve specimens of beef and mutton in bottle were fitted up in the usual way, and each kind of flesh was subjected to one-sixth, eighth, tenth, twelfth, fourteenth, and sixteenth of the gas diffused through coke vapour. Another similar set of twelve specimens were retained at home in the room, heated to 84° Fahr.

The results were fairly uniform in both sets of specimens. It was found that those structures which had been subjected to a tenth degree of dilution of the gas were preserved, while those submitted to a lower dilution were tainted or decomposed. In the specimens best preserved the colour was somewhat changed, assuming a rather rusty red, while in those to which an excess of the gas had been admitted, the colour was very dark. The gas consequently failed in respect to effect on colour, but if it had not failed in this particular, it was faulty in another way; it made the specimens so firm in structure that after they were exposed to the action of water, and were well cooked, they were hard and condensed. They were, in fact, like salted specimens of food, and in so far had lost their freshness. A specimen in the weakest dilution of the gas is on the table before you. You will see that preservation is fairly perfect, but the structure is a little discoloured, and it is too condensed.

Oxygen Gas as Ozone.—I observed in another stage of research that if that allotropic form of oxygen called ozone, which is, in common terms, a form of condensed oxygen, were driven in current through decomposed blood, that the blood was deodorised, and that it quickly underwent a process of coagulation. It seemed to me to be worthy of inquiry whether the exposure of fresh animal structure to ozone in a closed jar would cause preservation. I thought, perhaps, if the water of the structure were to become decomposed in the presence of the ozone there would be oxidation of the hydrogen and prevention of decomposition. Had I considered more carefully the conditions necessary for such oxidation, I should have seen that the result would not have been as supposed; but I did not see this until after the performance of the experiments about to be related, and I do not regret the circumstance because the experiments were singularly curious.

Six specimens of beef and six of mutton were placed in jars in the usual way, and the jars were then charged with oxygen transformed into the ozonised condition. The mode in which ozone is produced is shown in the apparatus Mr. Browning, the well-known philosophical instrument maker in the Strand, has been so kind as to lend me for this lecture. The oxygen gas is passed through a Siemens tube for generating ozone, and while it is passing it is subjected to the silent discharge from this large coil. The ozone was made to fill the jars containing the specimens by simple displacement of the air. After this the jars were closed, well sealed down, and packed in the wooden case, as in the other experiments, and the case was sent out to make the return voyage. The specimens returned with the bottles all intact, not a stopper loosened; but, on examination of the contents, on the fifty-fourth day after the day of preparation, I found that all the animal structure, except such of it as consisted of bone, was transformed into a

milky fluid, which was so intensely offensive it was impossible to examine it, but which poured out of the bottles in as liquid a state as if it had been milk. Not a shred of any muscular fibre remained, nor of fatty substance.

Oxygen Condensed by Pressure.—The failure of preservation with ozone did not prevent me from trying another experiment with oxygen in a different manner, and with a different result. I took a strong bottle with a thick neck, like this, which is on the table, placed in it muscle of beef, and charged it with ordinary oxygen gas. Then I put into the bottle a measured quantity of solution of peroxide of hydrogen, introducing the fluid in such a way that it did not come into contact with the meat until a cork was inserted into the neck of the bottle and tied down—after the manner of the cork of a soda water bottle. The bottle was then turned until a portion of the meat came into contact with the solution of peroxide. With that contact there was rapid evolution of oxygen and a pressure of gas equal to three atmospheres was produced. In this condition small specimens of beef were preserved through the return voyage, and came back in a state of excellent preservation. I particularly request your attention to the specimen which is now presented, and which has been in bottle for nine weeks, preserved in this manner. If there be any fault with it at all, it is that the colour may possibly be a shade too red. My view is that decomposition is prevented by the presence of oxygen under pressure. The fibre of flesh is everywhere permeated by the oxygen, and if there were any decomposition of the water of the tissues and liberation of hydrogen there would be the oxygenation not hydrogenation of the elements of the tissues, carbon, nitrogen, phosphorus, or sulphur, the result of which would be the formation of water instead of the offensive products of decomposition. That which occurs in living structures would here occur in dead. This preserved substance, in fact, is the nearest approach of structure actually dead to structure practically alive that you or I have ever seen. If we could penetrate, in our research, a little further, we should see a way by which we could keep the structures of dead animals in a form of suspended molecular life; and I once had a passing glimpse of the direction in which to work for this object. Unfortunately the idea slipped out of my possession before I had pinned it, and in striving to regain it I lost it more completely, in the same way as we sometimes forget a word and lose it further by striving to recall it. I have no doubt that by such a discovery as I now name the complete art of preservation will, in the end, be revealed, and by a very simple process be brought into perfect operation. Physically, it is a mere trifle of difference that separates life from death.

Cyanogen Gas.—The last of the gases I used for the purpose of preservation, in the series of research now under consideration, was cyanogen. This gas, as I daresay you all know, is composed of carbon and nitrogen, and when combined with hydrogen forms the poisonous compound known as hydrocyanic, or prussic acid. Cyanogen itself is a very poisonous gas, and I do not refer to it as an agent that can be made applicable, in the present state of our knowledge, for the preservation of animal substances intended for food. But the observations I have made upon it as a preservative are so simple, I am bound, in a description of scientific facts, to describe them. Cyanogen, composed of the two elements, carbon and nitrogen, has for its symbol CN. Under a pressure of four atmospheres it condenses into a liquid. It burns in the air with a purple flame. Water dissolves four volumes of the gas, and alcohol twenty-three. In my research I used a saturated alcoholic solution.

The mode of procedure with the specimens treated was precisely as in the other experiments with gases which have been recorded. The specimens of beef and mutton, two pounds each in weight, were placed in their glass jars, the jars were charged with coke vapour, and when they were quite ready, a measured quantity of the alcoholic solution of cyanogen was introduced into the jar from a graduated syringe. The stopper of the jar was immediately inserted, firmly secured in its place, and closely sealed down.

After many experiments to determine the quantity most applicable, I found that thirty minims of the alcoholic solution of the gas was the sufficient and just sufficient measure for the perfect result of preventing putrefactive change. In a jar charged to this extent decomposition is prevented under conditions of the most trying character.

Of thirty-six specimens that were sent out, on a return voyage all came back completely preserved. Of the same number of specimens retained at home, in the room heated up to 84° Fahr., all remained, in like manner, free of putrefactive change. Two specimens are now before us, which have been preserved in this manner, one for eight, the other for ten weeks. They are free of any change. In six months I shall expect to see them in the same condition if they be kept closed in their jars.

When a specimen so preserved is taken out of the jar it is found to be free of any taint of putrefaction. There is no escape of gas from the bottle; there is no change of colour; there is no unnatural softness and no unnatural hardness of the structure. The only peculiarity that is noticed is a faint odour of the cyanogen, which lasts even after exposure of the structure to the air for a long time.

Exposed to the air, the structure retains its freshness as long as fresh flesh does, and after it has been cooked it is preserved much longer than ordinarily cooked fresh meat. Two specimens of meat, one of beef, the other of mutton, after being preserved by this plan, and after making the return voyage, were cooked by roasting, and were placed in in a larder by the side of other specimens of beef and of mutton of the same size, which had been cooked, but in no other way treated. When these last were entirely changed, and were covered with mould, the cyanogen specimens were as fresh as ever. I replaced the changed structures by others freshly cooked, and when again these were decomposing, the cyanogen specimens continued good.

After keeping these cooked specimens eleven days, and finding that they no longer gave forth the odour of cyanogen, I fed a dog with some of the mutton, and as he was uninjured, I breakfasted myself on the remainder. The meat had been through an extreme test, a return voyage to Rio; exposure to the air uncooked for three days; and exposure after cooking for eleven days;—yet it ate as naturally as if it had been killed two

days only, and cooked but a few hours. All I can report about it as peculiar is that it had a very slight bitterness, like the bitterness which is tasted sometimes in eating pheasant. It was the taste of cyanogen in an extremely diluted form. In some natural meats, in the flesh of the pheasant specially, the same taste is commonly present.

So much at this moment for cyanogen. I have not yet done with the inquiry relating to it, and in another and perhaps more singular manner, it will come up again in the concluding lecture, on Monday next.

MISCELLANEOUS.

PARIS BLIND CONGRESS.

Among the numerous Congresses held this year in connection with the Exhibition, was one for the improvement of the condition of the blind, which closed its sittings on September 30th. The French Government did what they could to make this Congress a success. M. de Marcère, Minister of the Interior, presided at one of the sittings, and promised that he would do all in his power to back up some of the most important recommendations of the Congress. The morning meetings were held from 10 a.m to 12 in the Trocadéro, under the presidency of M. de Buffon, formerly chief of the Court of Cassation. M. de Buffon had a peculiar title to preside at these meetings, for he himself lost his sight a few years ago, and might, therefore, be expected to take a special interest in the improvement of the condition of his poorer fellow sufferers. The afternoon meetings and committees were held at the Tuileries. All the countries of Europe, where any attention has been paid to this subject, were represented; and about 150 members took part in the discussions and deliberations.

The first important point to be decided was whether, among the many systems of embossed characters, there was any which deserved to be recommended for universal adoption. The decision was nearly unanimous in favour of the Braille system, which, in point of fact, is so common that there were probably not more than one or two directors present in whose establishment the Braille character is not more or less generally used. The letters of this system consists of raised points variously grouped, by the combination of which the letters of the alphabet, as also shorthand signs, musical notes, and numbers can be represented. The letters are very easily felt, but the great recommendation is that by means of a simple and inexpensive apparatus the blind can write rapidly, and the writing so produced is exactly the same, or is as easily read by the finger as embossed printing. This enables a teacher to practise the pupils in writing from dictation, writing essays, translations, exercises in musical composition, &c. A great advance has been made within the last few years, by the British and Foreign Blind Association having constructed frames for writing on both sides of the paper, the lines on one side occupying the intervals of the other. Printing is now also done on both sides of the paper by means of stereotype plates prepared in a simple way by the blind themselves. This method of printing was examined with much interest by most of the members present, and is likely soon to become general. Its advantages are a saving of about 20 per cent. by utilising the spaces left between the lines, when one side only of the paper is printed; the greater facility of reading, arising from the wide interval between the lines; the advantage of being able to print frequent small editions of the work, thereby economising warehouse space, and avoiding the locking up of capital in large stocks of books. Lastly, and not least, the production of these plates gives remunerative and pleasant employment to the blind.

The next question was—Can blind children be satisfactorily educated in ordinary schools, and how is this best done? The importance of this point arises from the fact that in all European countries blind children are too numerous to be able to find admission into existing institutions, they must therefore either be educated in day-schools, or not at all. The only countries where anything has been done in this direction are Great Britain and Egypt.

The plan recommended by the Congress has for many years been adopted with satisfactory results by the Indigent Blind Visiting Society in London. It consists in the establishment of day-classes for the blind in different parts of the town, where blind children are taught by those processes which are best suited to the sense of touch, and as soon as they are able to read, write, and cipher, and have learnt how to use raised maps, they attend an ordinary school for the seeing on four or five days of the week, while on the other days they keep up and improve their knowledge of tactile methods of instruction at the special day-schools. This plan can only be satisfactorily carried out in large centres of population. In the country, or where from any reason special day-schools cannot be established, blind children can attend at an ordinary school for the seeing. They will not learn so much as if they also received special instruction, but even this education is far better than none. The Congress recommended that as in France the Braille system is already universal, and is simple and easily learnt, all teachers having blind children in their schools should be encouraged to learn it, and should receive a small increase of pay and some honourable distinction if they succeeded satisfactorily with their blind pupils. In Egypt, where blindness is about ten times as common as in Western Europe, there is scarcely a school without several blind children. These, it is true, learn nothing except by ear. They squat on the floor along with the other children, and learn the Koran off by heart, which they afterwards repeat at public and private ceremonies as a means of livelihood. The Cairo Institution for the blind contains only 40 pupils. The Braille system is used, and is found to lend itself readily to Arabic. The Koran printed in Braille is exhibited in the Egyptian department of the Exhibition.

M. Majorlin read an interesting paper on the ravages caused by purulent opthalmia in France. Of 208 pupils at present in the Paris Institution, 87 lost their sight from this cause, and 18 from small-pox. Purulent opthalmia is generally caused by dirt, and propagated by contagion from eye to eye. He insisted upon the necessity of isolating infected children, and of closer attention to vaccination. We in England have fortunately long recognised the necessity of these precautions, and such an amount of preventable blindness is quite unknown here.

Another topic discussed was whether the instruction of the blind might safely be confided to blind teachers. Here the antagonism to their blind fellow-labourers, still to be met with sometimes among the less enlightened seeing teachers, came out, but the counter proposition, that the blind could not be good teachers of the blind, was too absurd for serious discussion in the face of a blind chairman of Congress, and a number of blind professors from the Paris Institution. M. Simonon, the distinguished blind director at Namur, the most advanced institution in Belgium, and the example of some of the foremost institutions in different countries, in which not only many of the teachers, but the director himself is blind. To this list of blind leaders of the blind may be added the Council of the British and Foreign Blind Association, which consists exclusively of gentlemen who are totally or partially

blind. When this association commenced its labours, ten years ago, England was one of the most backward countries as regards the education of the blind; the system which the Congress considered worthy of universal adoption was not known or practised at a single one of our institutions, it is now, owing to its persistent advocacy by the association, used, more or less, in most of them. Educational apparatus for the blind was then of the rudest description; now England is without a rival in the production of such apparatus, and is sending it to every part of the civilised world. Then, it took years, and sometimes a quarter of a century, before methods of instruction became known to others; now, every fresh invention is at once examined by competent judges, and, if found useful, it becomes universally known in a few months.

It was decided by the Congress to form a society in Paris, with somewhat similar objects, and with branches in other countries. If this is wisely carried out, it is hoped that much permanent good to the blind of the Continent will result.

MUSICAL EDUCATION.

The following letter appeared in the *Times* of 28th October. It gives some information which seems from recent correspondence not to be generally known:—

Sir,—The expenditure of nearly £100,000 on "singing" in elementary schools is almost an astonishing discovery. After hunting for evidence of the fact in estimates and reports, it may be useful to state how the matter stands. You may look to the Parliamentary estimates of the year, and find nothing to help you, but it is paid out of a lump vote of nearly £2,000,000, without details. You may look to the report of "My Lords," and the statistics of the children passing in the three R's and several specific subjects, but you get no clue about the payments for singing. I have not been able to find even an enumeration of the numbers who are reported as singing and earn the grant of one shilling for "singing;" and the numbers can only be guessed at.

How came all this mystery about? The Code was created by Mr. Lowe in 1862, and 4s. was the fixed rate for the attendance of each child which Parliament sanctioned. In 1871 Mr. Forster raised the sum to 6s. In 1874 Lord Sandon reduced it to 5s., and the next year to 4s., and put 1s. for morals, and 1s. down for "singing" to be earned if the inspector reported that it was taught. But nothing was done by the administration at Whitehall to insure "singing" to be taught properly. The teacher might be unmusical and the inspector deaf. And no one in the Education Department cared about music except Mr. Hullah. He was re-appointed a musical inspector, and he has been able to do nothing but groan at the "singing" by ear, and no secretary or clerk at Whitehall has listened to him. Although 1s. was separated in the attendance grant for "singing," there are no statements showing how many shillings have been paid, and it is only by loose inferences that the sum may be estimated, £100,000, more or less. Perhaps the Audit-office could tell Parliament what the Education-office does not.

Now, I submit, £100,000 is ample for cultivating the musical ability of the 3,000,000 children, and for finding out who have especial musical ability worth cultivating. And I venture to express a hope that a committee of the House of Commons, will next session overhaul "singing" in schools as now paid for almost uselessly. A thorough reform is wanted, and it seems only necessary that some member should study educational reports, and codes, and estimates, and take evidence in a public committee to find out how musical education may be carried out effectively.—I am, your obedient servant,

Red Tape.

OBITUARY.

William Hooper.—Mr. William Hooper died on the 25th September last, in his sixtieth year. It was chiefly as the inventor and manufacturer of india-rubber insulated telegraph cables, and the founder of Hooper's Telegraph Company, that his name is known. He began life as a chemist, but afterwards went into business as a manufacturer of india-rubber goods; thence he was led to devote himself exclusively to the making of telegraph cables, and eventually his business was formed into a large limited liability company, by which, and by the original firm, it is said over 12,000 miles of cable have been laid, amongst others that belonging to the Cuba Submarine Company. Mr. Hooper became a member of this Society in 1857, and continued to subscribe to it till the time of his death.

GENERAL NOTES.

University of Sydney.—The New South Wales correspondent of the *Colonies* states that, in consideration of the necessity which is now felt for extending the curriculum of Sydney University and augmenting its teaching powers, the Colonial Government have consented to ask Parliament for an additional annual grant of £5,000. This will enable the Senate to make the following additions to the present course of study:—(1) Mental philosophy, law, history, and English literature; (2) all the education necessary for the medical profession; (3) a complete course of natural philosophy, coupled with mechanics and engineering; (4) the addition of organic chemistry and metallurgy to the chemical school; and (5) biology, including animal and vegetable physiology. The Senate will also be in a position to establish a faculty of science, and to confer the degrees of Bachelor and Doctor of Science, and also degrees in medicine, on those who have received their education in Sydney.

MEETINGS FOR THE ENSUING WEEK.

Mon.... Society of Engineers, 6, Westminster-chambers, 7½ p.m. Mr. Henry F. Knapp, "Harbour Bars, their Formation and Removal."

Social Science Association, 1, Adam-street, Adelphi, W.C., 8 p.m.

Tues.... Zoological, 11, Hanover-square, W., 8½ p.m. 1. Mr. R. Bowdler Sharpe, "On a New Species of Indicator, with Remarks on Other Species of the Genus." 2. Mr. G. B. Sowerby, jun., "Descriptions of Ten New Species of Shells." 3. Mr. A. G. Butler, "Description of a remarkable New Spider from Madagascar."

Society of Biblical Archæology, 33, Bloomsbury-street, W.C. (at 9, Conduit-street, Regent-street, W.), 8½ p.m. 1. Mr. Cust will report his having attended as a Delegate of the Society at the Oriental Congress at Florence. 2. Mr. Theophilus G. Pinches, "The Bronze Gates of Shalmaneser II. discovered by Mr. Rassam at Balawat." (Part I.)

Wed.... Geological, Burlington-house, W., 8 p.m.

Thurs... Linnean, Burlington-house, W., 8 p.m. 1. Mr. Lewis A. Bernays, "On the Existence of Carpesium (*C. Cernuum*) in Queensland." 2. Mr. Alfred W. Bennett, "Notes on Chrystogamic Flowers, chiefly of Viola, Oxalis, and Impatiens." 3. Dr. F. Buchanan White, "Descriptions of New Hemiptera." 4. Rev. George Henslow, "On the Absorption of Rain and Dew by the Green Part of Plants."

Chemical, Burlington-house, W., 8 p.m. 1. M. Kuhara, "The Red Colouring Matter of the Lithosperium Erythrorhizon." 2. Mr. L. T. Wright, "The Occurrence of certain Nitrogen Acids amongst the Products of Combustion of Coal-gas and Hydrogen Flames." 3. Dr. Wright and Mr. Luff, "Second Report on Researches on Some Points in Chemical Dynamics." 4. Dr. Frankland, "The Constitution of the Olefine Produced by the Action of Zinc on Ethylic Iodide."

Meteorological, 25, Great George-street, S.W., 7 p.m. Mr. John Knox Laughton, "Air Temperature; its Distribution and Range."

Fri....... Quekett Microscopical Club, University College, W.C., 8 p.m.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,355. VOL. XXVI.

FRIDAY, NOVEMBER 8, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

SOME ORIGINAL RESEARCHES ON PUTREFACTIVE CHANGES AND ON THE PRESERVATION OF ANIMAL SUBSTANCES.

By Benjamin Ward Richardson, M.D., LL.D., F.R.S.

LECTURE VI.—DELIVERED MAY 17TH, 1878.

The subjection of animal substances to preservative gases during test voyages was considered in my last lecture. Let me move now to some descriptions relating to the subjection of specimens, under the same conditions, to vapours of a preservative character.

A very large number of vapours were used in these experiments—the vapours of the alcohols of the nitrates and nitrites of methyl, ethyl, and amyl; of aldehyde; of methylal; of the hydrides or paraffins, light and heavy; of chloroform; of chloride of ethyl; of carbonic ether; of vapour from essence of mustard and other pungent or aromatic substances.

The mode of procedure was the same as in the previous researches. The specimens were placed in coke vapour, in bottles or in a metal cylinder, and the preservatives being added, the bottle or cylinder was closely sealed up and placed in the wooden case. In every instance, when a series of specimens were sent abroad, a corresponding series was retained at home for comparison. Of the vapours and essences named above all were failures, compared with cyanogen, sulphurous acid, and ammonia, except in the case of the vapour methylal. This vapour presented such good antiseptic power, it deserves a special note.

Vapour of Methylal.—The fluid methylal which yields the vapour, to the effects of which I am about to refer, is very little known. It was in fact a chemical curiosity until I began to experiment with it in 1867 in order to test its value as an anæsthetic or destroyer of sensibility. The fluid is composed of three atomic parts of carbon, eight of hydrogen, and two of oxygen. $C_3H_8O_2$. Its specific gravity is 0·885, compared with water at 1000, and it yields a heavy vapour, the density of which is 38 compared with hydrogen as 1. A specimen of pure methylal is here for inspection. It has been made for me by Mr. Williams, of the firm of Hopkin and Williams, of Hatton-garden, who is a master in the production of difficult chemical organic compounds. You will find it to be a fluid possessing a very pleasant odour, which makes it agreeable to inhale, and, as you will see, when I add some of it to water, it mixes readily with water, not so readily as common spirit mixes, but in large proportion. It is made by distilling together methylic alcohol and sulphuric acid in the presence of peroxide of manganese. The fluid is remarkable for its low boiling point. It boils at 108° Fahr. It therefore passes into vapour at a low temperature, and for that reason, among others, it is, like chloroform, a very powerful anæsthetic. For the same reason it soon envelopes any substance that may be enclosed with it, in a limited space, with a methylal atmosphere. It does more; the vapour being soluble in the water of the tissues, it acts after the manner of a salt, and permeates the whole of their structure. Diffused alone in contact with the red muscular fibre, it preserves and, at the same time, rather discolours the substance. It requires, consequently, to be diffused through oxygen or coke vapour, or coal gas, or carbonic oxide, that the colour of the substance preserved may be retained. It was applied in this mode of diffusion in the same manner as with previous specimens, in all my experiments.

In the usual way, twelve specimens, preserved in vapour of methylal, were sent on a test voyage, and twelve, preserved in a similar manner, were retained at home. The specimens consisted of six of mutton and six of beef, each one in a glass jar filled with coke vapour. The proportions of methylal were made alike in each series. One drachm of the fluid was put into a bottle containing beef, and the same into another bottle containing mutton; two drachms were put into two other bottles containing in one case beef, in another mutton. So through the series. The effect of different proportions of vapour yielded by amounts varying from one fluid drachm to six fluid drachms of the methylal was in this way tested.

The results were very uniform in the specimens sent abroad and in the specimens kept at home, the main difference being that in the specimens which went the voyage those submitted to six drachms of the vapour were found, on return, to have the stoppers in the bottles containing them loosened from expansion of the vapour. They were surcharged. All the specimens in both series were free of putrefactive change, except those in which a measure of one fluid drachm only had been employed. These were of good colour, but were slightly tainted.

Those specimens which had been treated with two or three fluid drachms of the methylal were best preserved. They retained their colour and were quite untainted. Those subjected to a higher charge yielded a considerable amount of red fluid, as though the vapour under pressure had extracted a portion of water from the tissues, with colouring matter, which fluid under contraction of the tissues had flowed out of them.

The best proof I can give you of the preservative action of methylal in vapour is afforded in the specimen which I will hand to the president for your inspection. That specimen, a portion of beef, has been preserved now forty-six days, and it is really difficult to see any difference in it from the

first day of its preservation. It is of natural colour, it is free of any taint of putrefaction, it retains its firmness.

What, then, are the objections to the use of this preservative, methylal, on a large scale? It is not poisonous like cyanogen, and it is very readily applicable. The objections are not numerous, and they may be removable, but they exist, and they are of these two kinds. The flesh, when it is cooked, is rather condensed like salted meat, and it possesses a slight flavour of methylal.

The facts about methylal are, at the same time, well worthy of permanent record. If we could find a fluid which, possessing all the physical qualities of methylal, was quite tasteless and quite inodorous, we should have a fluid very near to perfection. Indeed, further research with methylal itself is still required.

There are two specimens on the table, one of which shows that nitrate of methyl, and the other that nitrite of amyl, have each fair preserving powers; but I pass them over to refer, finally, to two other specimens which present results much more valuable.

Ammoniated Paraffin.—The first specimen in question represents one of a series which passed through the test voyage and returned singularly perfect. The method of preparation of these samples is the simplest of all we have had before us. A solution of ammoniated paraffin is made by driving well dried vapour of ammonia slowly through light paraffin, until the paraffin retains the odour of ammonia, and is slightly changed in colour towards a faint pink. When this solution is ready, no more requires to be done than to dip the portion of animal structure that has to be preserved into this solution, and then immediately transfer it into the preserving bottle charged either with coal gas or coke vapour, afterwards closing the jar safely. Structures treated in this way are, for all practical purposes, preserved from putrefactive change for any necessary length of time, and under every necessary strain. They are certainly good for four months. They retain very little of the ammonia, and they might be edible as far as that is concerned, but they unfortunately retain the odour and taste of the paraffin, from which it is impossible, up to this time, to free them.

Sulphuretted Paraffin.—In another inquiry, I passed hydric sulphide—sulphurous acid—through paraffin, and used the solution in the same way as in the case of the ammoniated paraffin. The results were equally good, as the second specimen here indicates, in fact, nothing could be better, were it not for the difficulty of removing the paraffin. You would think that in grilling the meat the paraffin would burn out, but it does not. It yields, even after the meat has been grilled, a disagreeable sense of its presence both in taste and smell. The ammoniated and sulphuretted paraffin solutions are at hand, and, in addition, some other similar solutions of benzoic acid and creasote, which also are good preservatives; but as they do not relate to our present practical inquiry, except in an incidental way, I pass them by.

Summary Respecting Gases and Vapours.

Out of much labour, ending in a load of negative results, in respect to the practical service of gases and vapours, we come, from what has been stated, to a few affirmative facts, which may be easily summarised. The best agents of the class of gases and vapours, are, ammonia, hydric sulphide, sulphurous acid, cyanogen, and methylal. For the perfect process of preservation, for a period of sixty days at least, all these may be accepted as preservatives which would bear any reasonable strain of heat and motion during transit from one part of the world to another, excepting always these accidental changes which now and then occur, and which yet remain unexplained. The four preservatives named preserve the structure of the animal substance only from decomposition; they do not preserve the colour. The colour can be preserved by carbonic oxide or by a medium containing carbonic oxide, such as coke vapour or coal gas, or by oxygen in the free state. Coke vapour is, on the whole, the most ready menstruum for use everywhere, and, I may add, that it is quite unobjectionable in regard to communication of taste or odour.

Ammonia fails because it is retained in the substance of the flesh, and gives an unpleasant taste.

Sulphurous acid fails because it does not preserve for a sufficient time after the specimen is removed into the open air, and because it imparts a slight acidity, destroys the natural odour of freshly cooked meat, and conveys, to a perceptible degree, the idea of a meat that has been salted.

Cyanogen fails for, I may say, the almost exclusive reason that it is a dangerous agent; unless it be used with the most scrupulous care it cannot be used at all.

Vapour of methylal fails in that it conveys a taste and the idea of a preparation by salting.

The ammoniated and sulphuretted paraffins fail because of the retention of the taste and odour of the paraffin.

I have thought it essential to put forward all these objections. They do not, I hope, destroy the worth of the research; they merely record its results in their entirety, good, bad, and indifferent. Had I been patent-minded in this work, I might have found the matter for half a dozen patents. My desire has been to follow up every result, its imperfections as well as its advantages, and to make both equally clear. In the end, it is likely that these partial failures will lead up to success; and, anyway, the report of failure may prevent some from falling into the same discomfiture.

On Certain Preservative Fluids.

For a few minutes I am about to diverge from the subject of the preservation of animal substances intended for food, in order to consider the art of preserving museum and laboratory specimens in preservative fluids. For such specimens, fluid preservatives are mainly useful. In the museum and laboratory, the use of wine spirit—ethylic alcohol—has long held the first place; but of late years methylated alcohol has been commonly used, owing to its cheapness. These alcohols preserve perfectly, but they are expensive, and they always bleach and destroy the flexibility of the structure that is immersed in them. Some other fluids, therefore, come in well for general use. I will give you a few of the best of these:—

Bichromate Solution.—Mr. Savory, who always makes some useful addition to our knowledge on

the rare—I regret to say too rare—occasions on which he speaks, described more than twenty years since the then new fact that bichromate of potassa is an admirable preservative when used in solution. The solution is made as follows:—

Potassa bichromate, 3 grains.
Water (distilled), 1 fluid ounce.

This solution preserves and does not harden the structure. It rather destroys colour, causing the colour to change towards a greenish tint. To prevent this change, the following modification may be adopted:—

Potassa bichromate, 3 grains.
Potassa nitrate, 2 grains.
Water (distilled), 1 fluid ounce.

Both solutions keep very well, and nothing more is necessary in using them than to suspend the specimen to be preserved in a preserving jar, and add the solution.

Zinc Colloid.—Zinc colloid is a fluid I have myself introduced, and it is useful where it is necessary to preserve and at the same time fix or harden a tissue. The preparation is made as follows:—

Tannin, 10 grains.
Alcohol (sp. gr. ·830), 4 fluid drachms.
Tincture of benzoin, 1 drachm.
Colloidon, 3 drachms.
Zinc chloride, 5 grains.

Dissolve the tannin first in the spirit; add the benzoin and the colloidon, and finally drop in the zinc chloride in very small pieces and slowly, until a complete solution of it is secured. This preparation is laid on to the structure with a brush. Very little of it is required.

Carbolic Colloid.—Another preparation in the colloid form is made, as above, but instead of zinc chloride, carbolic acid is introduced in the proportion of three to five grains to an ounce. This solution, laid on with a brush, preserves membraneous structures very efficiently.

Diffusible Creasoted Fluid.—For spongy textures, and for fur, feathers, or hair, creasote answers admirably, if it be neatly applied. For this purpose, the following solution is good:—

Pure beechwood creasote, 10 minims.
Amyl hydride (sp. gr. 0·620), 1 fluid ounce.

Let the creasote dissolve in the hydride; stop the bottle well and keep in a cold place.

In using this solution, it is only necessary to pour a little of the solution on the specimen to be preserved, and then gently blow with the warm breath, over the part where the solution is laid. The light amyl hydride, which boils at 88 deg. F., will all evaporate instantly, and will leave the creasote, in a state of the finest subdivision, on the structure.

Diffusible Iodine Fluid.—Sometimes a substance about to be examined has become somewhat tainted already, and requires to be deodorised. For this purpose, the fluid I call diffusible iodine is useful.

Iodine pure, 5 grains.
Amyl hydride (sp. gr. 0·620), 1 fluid ounce.

Let the iodine dissolve, close the bottle firmly, and keep in a cool place.

In using this solution, pour a little on the specimen and blow gently to evaporate the hydride. The iodine will be left in a state of fine subdivision, and will quickly deodorise.

Diffusible Bromine Solution.—

Bromine, 5 minims.
Amyl hydride, 1 fluid ounce.

Let the bromine mix with the hydride, stop the bottle closely, and apply as above directed for the use of the iodine solution. This bromine solution is very effective, but is not quite so manageable as the iodine. It affects the breathing if inhaled as vapour.

Mem.—The last-named two solutions are applicable for many other purposes; they are splendid disinfectants as well as deodorisers. They require to be used with care in the presence of a light, the vapour of the light amyl hydride being very inflammable. Amyl hydride is sometimes sold under the name of rhigolene.

Diffusible Benzoin Solution.—In the same class of specimens, I mean where there is a taint or odour of decomposition, it may be wished to use a deodoriser which yields an agreeable odour. For that purpose, the following answers well:—

Benzoic acid, 5 grains.
Alcohol (sp. gr. ·830), 2 fluid drachms.
Amyl hydride (sp. gr. 0·620), 1 fluid ounce.

Let the acid dissolve, close the bottle carefully, and keep in a cool place. The solution is used in the same manner as the two immediately preceding. This solution may also be employed for deodorisation of the air, in the same way as the two last, and with the same precautions.

Strong Iodine Deodorising Solution.—In some cases a specimen is so thoroughly decomposed, it is quite impossible to examine it until it is deodorised. Such a specimen may be rendered free of odour and firm, by being treated with the solution described below:—

Iodine, 5 grains.
Alcohol (sp. gr. 0·830), 1 ounce.
Sulphuric acid (strong), 5 minims.

Dissolve the iodine in the spirit, and add the acid slowly. This solution should be made fresh each time for use, and the specimen should be just covered with it and left in it for a few hours. The specimen will be rendered free of odour of putrefaction, firm, and preserved. Covered afterwards with spirit simply, it will lose much of its dark colour, and re-assume a very natural appearance.

Solution for Arsenical Washing (Tranchini's).—For a preservative arsenical solution, Tranchini's is most ready—

Arsenious acid, 3 grains.
Cinnabar, 1 grain.
Alcohol (sp. gr. 0·830), 1 fluid ounce.

Mix, and frequently agitate the solution. This solution is useful for preserving skins of animals. It has been used also for embalming.

Preserving and Bleaching Solution.—A specimen naturally white in structure may become changed of a dark colour and be decomposing. To preserve such a specimen, there is no solution so good as the following:—

Alcohol (sp. gr. 0·830), 10 fluid ounces.

Put the alcohol in a flask, surround the flask with ice water, and then pass sulphuric acid gas, made by the action of strong sulphuric acid on

copper turnings, through the alcohol, until bubbles begin to escape freely. After this take away the gas and close the flask containing the saturated alcohol securely.

This is a most useful solution to have at hand. A very little of it applied to a specimen, deodorises, bleaches, and preserves.

Corrosive Preserving Solution.—

Mercury bichloride (corrosive sublimate)	10 grains.
Alcohol (sp. gr. 0·830)	1 fluid ounce.
Acid hydrochloric (sp. gr. 1·16)	10 minims.

This solution is useful for the preservation and hardening of very soft structures, such as the brain and spinal cord. The most perfect specimens of preserved brain I have ever seen were preserved with this solution.

Pacini's Solutions for Minute Structures.

Professor Pacini employs the following solutions:—

	I.	II.	III.	IV.
Corrosive sublimate	1	1	1	1
Chloride of sodium	2	2	1	—
Distilled water	100	200	300	300

	V.	VI.	VII.
Corrosive sublimate	1	1	1
Acetic acid	1	3	5
Distilled water	300	300	300

	VIII.
Corrosive sublimate	1
Phosphoric acid	1
Distilled water	300

No. I. he uses for all vascular tissues of the human body, or of warm-blooded animals, such as pieces of a hyperæmic peritoneum, villi of the placenta, &c.

No. II. for the corresponding tissues of cold-blooded animals.

No. III. for cells, pus, infusoria, spores.

No. IV. is to be substituted for No. I. in all cases where the blood globules, which are so easily destroyed by chloride of sodium, are to be preserved intact.

No. V. is sometimes preferable to No. III., the acetic acid rendering the nuclei more distinct.

No. VI. is to be used for all fibrous tissues, muscles, and nerves.

No. VII. for glands; and

No. VIII. for cartilages.

Salts for Preservation of Animal Substances as Foods.

It is time to return to the preservation of alimentary animal substances, and this return leads me to refer to the action of salts as preservatives. Whenever it was made it was a great discovery, that the adding of common salt to freshly killed animal food made the food keep. The discovery is too ancient for us to trace, and I suppose the clever men who first made it troubled themselves as little about the mode of action of the preservative as our drysalters and other salters do at this day. Still, the action of common salt and of all preservative salts should be understood, and it is easy to understand it, because it is so simple. The salts preserve according to their solubility and their stability. As a rule, the more soluble the salt the better it preserves, if it be also of stable composition. Common salt (sodium chloride) preserves well because it is very soluble and very stable. The salts differ in effect as to the preservation of the colour of red animal fibre. All the chloride salts darken the colour; some of the nitrates also darken or discolour. One of them, common saltpetre (potassa nitrate), preserves colour, so it is frequently used in the process of salting.

The diffusible salts, one and all, prevent the pectous change in colloidal fresh fluids. This is due to their diffusibility and to their power of fixing the water. They act as intermediates between the water and the colloidal material. For this same reason they preserve animal colloidal structures from the process of decomposition. They fix the water. The first of these two facts was shown, by experiment, a few lectures ago; the second is demonstrated in all specimens of salted foods.

Again, salted foods redemonstrate the effect of the salt in holding colloidal matter in the aqueous state, by the diseases they produce, on persons who are obliged to subsist on them for too long a time. They produce, through the salt they contain, an extreme fluidity of blood, and the disease called scurvy.

As preservatives the salts have many advantages. They are cheap, they are ready for use, they are easily applied, and the stable ones are certain in effect. The preservation they cause is not interfered with by any of those subtle changes which we have seen to interfere with the action of the gaseous compounds. The disadvantages of the salts, as preservatives, are that they add weight to the substance preserved, that they cause hardening of the substance, that they change the value of the food, reducing the value of it per weight, and that they cause disease if they are taken for too long a time. The last of the tables of M. Mène is very instructive in respect to some of these points, showing the relative value of fresh and salted animal foods.

Researches with New Salts.—In my research I did not think it necessary to investigate the action of the commonly used salts. Indeed, I let the plan of mere salting with a fixed salt go by altogether. I had another object in view, which was new in its intent.

It occurred to me that possibly a salt might be found which would preserve, under ordinary conditions of transport and of housing, but would decompose in the process of cooking the food which it had preserved. I sought, in a word, for a salt which would fix the water of the tissues so long as we desired, and, under a change of condition which might easily be controllable, would disorganise, and breaking up into secondary or primary parts would pass off, leaving the water diffused, in the natural way, in the structure of the colloid.

If this were not easy of accomplishment, I thought again, it might be possible to employ a salt that would be so diffusible in water that, when it was desirable to remove it from a substance which it had for a time preserved, it would merely be necessary to wash the preserved substance freely in water in order to take out the whole of the salt at once. The housewife now soaks the salted structure to remove the fixed preserving salts.

Can a salt be found so soluble that the time required for "soaking" shall be reduced to the mere time required for dipping or washing the structure.

It will be seen that both these plans were worthy of much labour and experiment, and I devoted much to the inquiry, though I confess, not enough. There is a great deal yet to be learned in both these suggested methods. What I have gained, however, is yours, and it opens the way, if it does no more.

Experiments with Urea.—Remembering, from the results of previous experiments, the preservative action of cyanogen and ammonia, it very naturally occurred to me, when I began to study the salts under the ideas above stated, to test the action of a very singular organic animal salt called urea. This salt is a modification of ammonium cyanate, and is composed as follows:—$C\,O\,H^4\,N^2$. It is made in animal bodies, and is the natural saline constituent of the urine of man, in which it is formed in the proportion, according to Thudichum, who is one of the best authorities on the point, of 30 to 40 grammes in the twenty-four hours. Reduced to our common expression of weight we may say that the full average proportion is 576 grains in the 24 hours, or 24 grains an hour.

We are not, however, obliged to go to this source for urea. The labours of Liebig led to the discovery that this organic salt can be manufactured out of the body by bringing together dry ammonia and cyanic acid to make cyanate of ammonium, and then leaving that salt to undergo spontaneous change into urea. Urea is made also by other processes, but I wait merely to state that it admits of artificial construction.

I pass round a very perfect specimen of urea manufactured by Mr. Williams. You will see that it is a beautiful white crystallised salt, the crystals of needle shape. It dissolves in its own weight of water at 60° Fahr., and the solution has a saline slightly bitter taste, like solution of saltpetre. Urea easily decomposes by heat, and if it preserved animal structure it would, I conjectured, be readily disposed of by means of washing and heat when it had served its purpose.

To test the preserving power of urea, specimens of muscle of beef and mutton were treated with it, as in the ordinary process of salting, in varying proportions of from one drachm (60 grains) to four drachms (240 grains) to the pound weight of substance. The salt was well rubbed into the fresh meat, and the meat was then put into the preserving jar, charged with common air or with coke vapour.

The result of these experiments, in the preliminary stage, established the fact that urea is a preservative salt, but they did not warrant the further trial of it by a test voyage. The animal substance was perfectly preserved when the urea was used in the proportion of two drachms weight to the pound of animal structure. But at so low a temperature as 65°, the urea, in presence of the meat, owing to the influence of a ferment, itself underwent decomposition. It was resolved into ammonia carbonate, and the ammonia so produced became the preservative, with all its advantages and all its failures. The actual preservative effect of urea, as urea, is limited to 10 days at 65° Fahr.; at the end of ten days the first indication of ammonia is presented. Previous to that, the meat remains in excellent preservation, and compares well with other meat that is left in the jar without a preservative. The meat preserved by the urea is a shade darkened in colour, unless it be placed in an atmosphere of coke vapour, but it cuts firmly, and in process of cooking by roasting, the urea is decomposed and evolved. There are three specimens of beef on the table that have been preserved in urea in the manner described. They have been subjected to the salt at different temperatures; one at 45° Fahr., the other at 55° Fahr., the third at 65° Fahr. The one preserved at the highest temperature is faintly ammoniacal; the other two are perfectly fresh, and after cooking, are quite fit for food. There is another specimen which has been treated with the same quantity of urea, and which, in an atmosphere of coke vapour, has been kept for fifty days at 65° Fahr. To all appearance it is quite fresh, but it has been ammoniacal for forty days out of the period named. The meat is not decomposed, but it is charged with ammonia from the decomposed urea.

Ammonium Nitrite.—There is another very soluble and easily decomposed salt called nitrite of ammonium. It is a beautiful crystallised salt when dry, as will be seen by this specimen, but it absorbs water with such rapidity that it becomes deliquescent in a few minutes. This salt promised good results if it were sufficiently stable in composition. It is decomposable by heat, and it is readily removable by water—two great advantages in its favour. It was put to the trial in a series of preliminary experiments in the same manner precisely as urea had been tried. The results were almost entirely the same. The salt darkened the animal structure slightly, when the structure was kept in common air, but not when it was in coke vapour. The salt preserved at 65° Fahr. for ten days excellently, but then it underwent decomposition, giving to the preserved structures an ammoniacal odour. Two specimens are shown in illustration.

Acetate of Soda.—Acetates and Citrates.—Acetate of soda has been recommended as a preservative, and it is reported to have been successfully employed. I submitted it to experiment in the usual way, on specimens in a jar charged either with common air or coke vapour. It preserves but has no advantages. In the end it darkens the specimens, and full five per cent. of the salt is required to sustain preservation. The meat so treated is condensed and saline. The salt is not easily removed by steeping the meat in water, nor is it decomposed in the process of cooking the meat that has been preserved by it. The acetates of potassa and ammonia were tested in the same manner, and with the same results. They preserve, when used in proportions of five per cent., but they render the structure condensed, and they darken the colour.

There are six specimens of beef preserved by these acetates. Three of them, which retain the natural colour, are in coke vapour; three, which are darkened, are in common air. There are also other six specimens in which the corresponding *citrates* of soda, potassa, and ammonia have been tested. These salts all preserve well, and to the

same extent as the acetates. Five per cent. of them is required.

Ammonium Sulphide.—Ammonium sulphide was tested in a preliminary way, and found to be an exceedingly good preservative for a period of twenty-eight days. The sulphide was dissolved in alcohol to complete saturation, and the alcoholic solution was employed in experiment. The specimens, one pound in weight of mutton and of beef, were placed in the glass jar charged with coke vapour. Two fluid drachms of the alcoholic solution was poured into the jar, and the stopper was inserted and carefully sealed. The specimens, put into a wooden case and surrounded with sawdust, were left in the chamber heated to 84°. At the end of twenty-eight days they were found to be quite fresh and firm, and free of any taint. The mutton was a little darkened, the beef was of perfectly natural colour. Both specimens were cooked and eaten. The mutton was faultless. The beef was tender and tasted like beef that had been hung until it was just free of taint.

Further experiments are required with this preservative. As will be seen by two specimens that have been kept by it for twenty-eight days it is close upon a success.

Formate of Soda and Formates of Potassa and Ammonia.—The acid called formic acid ($C\ H_2\ O_2$), the acid got by oxidation of methylic alcohol, and holding the same position to methylic alcohol that acetic acid bears to ethylic, joins with many bases to form salts called formates. These salts are soluble, though more fixed than urea and nitrite of ammonium, and are decomposed more readily than the acetates, nitrates, or chlorides. Specimens of all these salts, prepared by Mr. Williams, are presented for your inspection. The results of experimental inquiry in respect to one of these salts, the formate of soda, were most important, and some, with the formates of potassa and ammonia, were of interest. The latter, however, were so far inferior to those from the formate of soda, I shall confine myself to description of the soda salt alone.

The formate of soda was applied in experiment in the same manner as the urea. The specimen, after being salted with the formate, was placed in the preserving jar, charged with common air or coke vapour. Then the jar was closed and transferred to the wooden case, and carried to the heated chamber where it was kept for observation. At first I began to use the salt in the proportion of five per cent., one ounce of the salt to twenty of beef or of mutton. Finding that this was sufficient, I reduced the quantity to four, and again to three and to two, per cent. By this means I found that, for practical purposes, three per cent. was sufficient, and that less was insufficient. It was a gain to find that so little as three per cent. would suffice.

A few experiments showed that when specimens were preserved by the formate of soda in common air they changed greatly in colour, but that in coke vapour they retained their colour. After this observation, all the specimens were placed in coke vapour.

The preliminary experimental inquiry showed that the proportion of three per cent. of the formate would keep the substances, beef and mutton, subjected to it for six weeks, in an excellent state of freshness. When the specimens were removed from their jars, and washed, they were cooked, and ate more like fresh meat than any other salted specimen that I have seen. The presence of the salt was imperceptible. After this, structures similarly preserved were sent out on a test voyage, and returned in excellent condition after forty-five days of preservation.

The most striking results obtained by the use of the formate of soda were in two specimens, one of beef and one of mutton, prepared as follows. The meats were salted, with formate of soda in the proportion of three per cent., and were then suspended for twelve hours in jars charged with carbonic oxide. After this suspension, hard paraffin that had been melted was poured into the jars around the specimens until the jars were filled, and the paraffin cooling afterwards, the specimens were enclosed in it as closely as if in ivory. The meats, so prepared, were retained at home, in the heated room, for thirty-six days. Then they were sent out on the tropical test voyage, and came back in forty-five days. Lastly, they were kept at home until the eighty-third day, when they were removed from their jars and examined.

The report on these specimens is, that the jars containing them were whole, and the stoppers firm, but a little odourless air escaped on removing the stoppers. The meats were faintly acid in reaction; they were absolutely natural in colour; they were free of all taint. Roasted they ate with perfect natural taste and flavour, and were exceedingly tender.

For your examination there are four specimens of beef preserved with the formate of soda. They have been preserved, with three per cent. of the salt, for 40 days, and they answer for themselves. I have no hesitation in saying that a distinct advance in the art of preservation has been made by the research with formate of soda. I do not claim for it a great advance, but it is a true one as far as it goes, and it shows a proper direction in which to continue to inquire. The formate of soda is a little too stable, and it does not itself preserve colour. These are its chief defects.

I have yet on my notes the records of a series of experiments made with sugars,—cane sugar and glucose (grape sugar),—in combination with sulphurous acid and other preservatives. I have also notes of another series, in which specimens of animal structure were subjected to a process of salting by gaseous diffusion, the flesh being impregnated with two gases in such way that the gases would combine to constitute the salt within the structure itself. In each of these lines of research the results that have been obtained are useful and important, but I must leave them for some future time, in order to describe them in detail, and I must be content now to touch on one or two concluding topics.

Practical Notes.

From the evidence we have had before us we have elicited the following facts :—

(*a.*) Preservation of colour and of substance are distinct processes. Some preservative substances preserve colour, but not substance, and *vice versâ.* Both plans can, however, go on together in preserving. In the ordinary process of decomposition, colour is destroyed under the influence of the newly-made ammonia and sulphur compounds.

Loss of colour is, therefore, a sign of decomposition. We can fix colour by two agents at least—oxygen and carbonic oxide.

(*b*.) In the preservation of colloidal animal substance the point is to remove or fix the water, and we know why this is the point to be attained. We have seen that drying preserves, but leaves the structure incapable of reabsorbing water. We have seen that salts preserve like the process of drying, but leave the substance heavier, charged with a new body and harder than is natural. These objections in relation to the salts may in time be overcome, by following up the plan of seeking for a salt that can be easily removable by washing, or that can pass away in cooking. We have advanced in this direction by the trial of urea, nitrite of ammonium, and formate of soda.

(*c*.) Besides these means we have at command, in addition, the controlling influences of cold and pressure.

(*d*.) Cold is an important adjunct in maintaining preservation, because acting like a salt it fixes the water of the colloidal matter But heat may, under some conditions, be also used for preserving processes.

(*e*.) Heat and cold both, therefore, admit of being utilised, and some inquirers are hopeful that cold, below 35° Fahr., may be all sufficient when the means of maintaining it are perfect. My own view is not at present in favour of this hope. Cold of itself preserves, but not well. Under cold, colour is modified. If the air be dry, the preserved structure desiccates. If the air be moist, the preserved structure undergoes a slow decomposition which makes it unpleasant to the taste and destroys freshness.

(*f*.) The perfection of a result will, I think, be obtained, when temperature can be reduced to a mean which is perfectly equable, and can be adapted to the action of a good preservative atmosphere. And it has occurred to me that the sea itself would afford such a medium. If, in connexion with a ship, there could be a submerged water-tight preserving vessel, the difficulty of keeping up an equal temperature would be largely got over. In such a vessel, contained preserving gases could be held under pressure without extra cost. It is out of my range of research to plan such a vessel, but I cannot but believe that a skilful engineer, by lending his mind to the subject, now that he has the idea, could easily make a vessel that should meet the requirements. This done, fresh food might be brought from any part of the world, by sea, with perfect readiness, and I trust that if my researches have brought out no more than this suggestion, they will be of service. The suggestion is one which, I hope, the Society of Arts will not let pass into silence. If the plan of a submerged preserving tank were adopted, any vessel that was steaming from a foreign port could, without interference with her own freight, bring home with her food for the people. We have invented torpedo ships for the destruction of life; why not, by a new application of a similar construction, invent submerged vessels for the carrying supporters of life?

(*g*.) In respect to chemical research, in continuation of the plans I have put forth, the preserving substance required from the chemist should have the following properties:—It should be a gas or salt, having the property of fixing water. It should be sufficiently stable to resist decomposition of itself up to the temperature of 120° Fahr. It should not be poisonous. It would be advantageous if it preserved the colouring principle as well as the structure of food, but this is not essential. It should be easily separable from the preserved substance, by the process of washing, or by the process of cooking, so that the substance shall lose nothing in weight, and gain nothing that is extraneous to itself. It should be convenient for manipulation, and not explosive. On a large scale, when all apparatus for the use of it has been fitted up, it would be most convenient to work, if it were in the gaseous form. It ought to retain its power of preserving in bottle for an unlimited time so that the poor might buy the preserved substance in small quantities, and always have it on hand fresh. It ought to retain its power of keeping up the freshness of the substance for five or six days after exposure to the atmosphere. The chemical substances which require to be tested further are very numerous. All the nitrites of the organic series should be tested; all the formates. Urea requires to be put to the test in various other methods than I have yet tried, and many organic basis of similar type call for similar inquiry as to their value.

(*h*.) Soon after an animal is killed, its muscles undergo the change called *rigor mortis*. This is due to the coagulation of the fluid within the muscles. It is a question whether the attempt to preserve should be made before or after this change takes place. I am of opinion it should be made before the change occurs, as the diffusion of a preservative through the structure is then more ready and active. Heat favours and intensifies the coagulation, and in tropical weather the preservation should be made the instant the animal is slaughtered.

(*i*.) Another suggestion refers to the selection of saline preservatives in relation to health, in cases where crews or travellers have to subsist for a long time on salted foods. It deserves trial, whether such foods preserved by the citrate and formate salts would not be taken longer without producing scurvy than the salts now employed.

(*k*.) Without suggesting further research, I venture to express the belief that we are even now very near to perfection of results, and that a continuous systematic inquiry must ensure success. The specimens on the table at this moment are such good evidences of this fact in themselves, it requires no further comment on this occasion.

THE GERM HYPOTHESIS OF PUTREFACTION.

This course of lectures would not be complete unless a reference was made to the hypothesis which tries to explain putrefactive changes by supposing that these changes are due to a kind of fermentation, produced by minute living organism or germs, which are present in the air, and which, coming into contact with the dead animal structure, excite the changes. As an original inquirer, I do not feel it my business to say much on the controversy bearing on this hypothesis; but it might be thought, if I let it pass without a word, that I had been guilty of omitting something essentially important.

The germ hypothesis has been very differently

treated by different authors. On one side it has been subjected to derision, on the other side it has been extolled to childish adulation. It may be said to have started with the observation of Redi, that the exclusion of dead animal matter from something in the air, which could apparently be filtered out of the air, arrests putrefactive change as it might arrest the introduction of the ova or germs of other living forms, such as maggots, in the same substance. We have seen in our experiments—there is a specimen on the table as an example—that exclusion of air does, for a time, under some circumstances, interfere with commencing putrefaction.

This looks like truthful demonstration. Yet still it is a very easy thing to oppose the hypothesis altogether. We can show, for instance, that animal tissue decomposes in the closest chamber; that animal tissue decomposes when embedded in hard paraffin; that animal tissue decomposes when coal gas or other negative gas takes the place of air. All these facts indicate that air is not wanted either to act itself, or to convey particles or germs. But it may be urged on the side of the hypothesis, that the dead animal substances, before the time when they were subjected to these exclusive tests, had been exposed to the infection of germs.

To this defence of the hypothesis there is an experimental answer. Here is a specimen which, after it has been subjected to the air itself, under pressure, has not decomposed; and here are many specimens which have been exposed to the air, but because they are charged with a small part of a salt, or gas, or vapour, have not decomposed. Thus a substance may be exposed to the air and may not change. All our salted provisions may be used as arguments in support of this truth.

There will again be a ready answer to suit the hypothesis, namely, that under such conditions germs cannot live. The conditions are fatal to life in any form. How can germs live in cyanogen, or sulphurous acid, or under atmospheric pressure, beyond what is natural?

The answers are plausible, and the germ hypothesis might be defended possibly on them if there was nothing else to be said. But there is more behind. We can arrest life in action and still have decomposition. If I were to put a firm ligature round one of my limbs, and so completely cut off the supply of blood from the limb, I should do the most effectual thing for cutting off the supply of germs into that limb, if germs really do enter it. Thereby, I ought to stop decomposition of that limb, for I have cut off both oxygen and blood from it. Nevertheless, the muscles of the limb will of a certainty decompose. My explanation why the limb decomposes, under those circumstances, is clear enough. I would say that I have left the water of the tissue, subjected to agents in the blood itself, fibrine, and blood cells, which are alone sufficient to decompose the water of the tissues, and that as I have cut off the supply of blood that was entering the limb, the liberated hydrogen, in the nascent state, combines with the nitrogen and other elements of the nitrogenous textures, and sets up the series of decompositions—or re-compositions—called putrefactive changes.

Is there, then, no truth at all in the germ hypothesis? There is, I think, a germ of truth. I believe it is probable, from the two circumstances, that filtration of air does, in some structures, check putrefactive change, and that in these instances new forms of life are developed. From these two circumstances it is, I repeat, probable that there may exist in the air minute organic particles which, coming into contact with the water of colloidal structures and fluids, are capable, like fibrine and blood cells, of starting the decomposition of water, and so exciting putrefaction. Germinal particles may thus be added to other and much more abundant materials capable of exciting the change. This is all I have to say, from what I have seen, in support of the germ hypothesis; and, indeed, in saying so much I am rather acknowledging certain facts which, at this moment, do not admit of other explanation, than putting forth an affirmative opinion.

Conclusion.

The research, on which these lectures is based, has been laborious beyond any I have ever made. It has been an unpleasant labour often, sometimes dangerous for the moment, and not very popular. But it has been a study yielding rich fruits of observation, amidst abundance of failures and unexpected turns of result. My purpose has been to place before this Society, and through it before the world, that which I have learned, unreservedly, good and bad alike. I make no claim to have practically solved one of the greatest problems of the day, but I know I have brought the principles on which that solution must rest to a new stage, for practical advancement from which successful discovery may follow, as I hope speedily, to the credit of industry research, and to the benefit of mankind.

MISCELLANEOUS.

NATIONAL MUSICAL EDUCATION.

Sir Henry Cole, who has been residing in Manchester for several months, interested in seeing how far the report of the Lords' Committee on the Pollution of Rivers can be carried into effect in Lancashire, has also been active in promoting Musical Education in the county, and he sends the following announcement, which he requests may be published as quite consistent with the past action of the Society:—

Lancashire Association for the Cultivation of Music among all.

The object of the association will be to promote the general cultivation of music as a most important agent for promoting the moral culture of the people; also "to create a popular interest and sympathy, a spontaneous co-operation of the many, the concurrence of genius, and a spreading thirst for the art and science of music," which, as Plato says, "ends in the love of the beautiful." It is thought that these objects may be attained (I.) by improved teaching in all elementary schools, to which Government already makes for singing the grant of one shilling per child in attendance, costing nearly £100,000 a year; (II.) by establishing schools or classes in large towns in the county for training musical teachers for elementary schools to be aided by

Government grants; (III.) by giving free instruction at the National Training School to very promising talent ascertained by competitions, such schools being supported, like elementary instruction, by public grants; (IV.) by encouraging singing on week day evenings, in churches and chapels when not otherwise used, and generally to take measures for restoring music to the popular position it held three hundred years ago.

General Promoters of the Association.

President—The Lord Bishop of Manchester, Bishops' Court, Manchester.

The Countess of Derby, Knowsley.
The Earl of Wilton, G.C.H.
The Countess of Galloway.
The Bishop of Salford.
The Dean of Manchester and Mrs. Morgan Cowie, Deanery, Broughton-park.
Sir Henry Cole, K.C.B., Lady and Misses Cole, 49, Wilton-place, Higher Broughton, Manchester, *Hon. Sec. pro. tem.*
Peter Allen, Esq., Higher Broughton, Manchester.
The Rev. E. Preston Anderson, St. Gabriel, Hulme.
Mr. Alderman Bennett, Manchester.
The Rev. Canon H. M. Birch and Mrs. Birch, Prestwich-rectory, Manchester.
Mrs. Davy Bowers, Hulme, Stretford, Manchester.
The Rev. G. M. Burton, D.D., 4, Cecil-street, Greenheys.
Mrs. Burder, Polygon, Cheetham-hill, Manchester.
J. B. Close, Esq., Eccles.
T. Dickens, Esq., J.P., and Mrs. Dickins, Edgemoor, Higher Broughton.
S. Dill, Esq., M.A., Manchester Grammar School.
The Rev. Minor Canon Elvy, M.A., 1, St. Luke's-terrace, Cheetham, Manchester.
J. H. Ewart, Esq., and Mrs. Ewart, Cheetham-hill, Manchester.
The Rev. W. Gaskell, M.A., and Miss Gaskell, 84, Plymouth-grove, Manchester.
Mr. Councillor Goldschmidt, Rusholme, Manchester.
F. W. Grafton, Esq., and the Misses Grafton, Manchester.
Principal Greenwood, LL.D., the Owens College, and Mrs. Greenwood, Chorlton View, Fallowfield, Manchester.
C. Hallé, Esq., Manchester.
Edward Hecht, Esq., Lecturer on Harmony and Music in the Owens College.
Mr. Alderman Heywood, late Mayor of Manchester, Summerfield, Bowdon.
Charles Heywood, Esq., and Mrs. Charles Heywood, Chaseley, Pendleton.
Oliver Heywood, Esq., Manchester.
Henry Lee, Esq., J.P., and Mrs. Lee, Sedgley-park, Manchester.
Miss Leisler, Manchester.
The Rev. W. J. Knox Little, M.A., Cheetham, Manchester.
The Rev. A. MacLaren, D.D., Manchester.
Hugh Mason, Esq., Ashton-under-Lyne.
Councillor G. H. Midwood, 55, Faulkner-street, Manchester.
Mrs. Morgan, Eccles.
Mrs. H. M. Ormerod, Broughton-park, Manchester.
W. Felton Peel, Esq., and Mrs. W. F. Peel, Broughton-park.
Mrs. Herbert Philips, The Oakhouse, Sutton, Macclesfield.
E. Crompton Potter, Esq., and Mrs. Crompton Potter, Rusholme-house, Manchester
J. Kendrick Pyne, Esq., organist of the Cathedral, Manchester.
Rev. G. W. Reynolds, M.A., Rector of S. Mark, Cheetham-hill.
H. J. Roby, Esq., and Mrs. Roby, Pendleton, Salford.
Professor Roscoe and Mrs. Roscoe, Victoria-park, Manchester.
Mrs. Salis Schwabe, Naples.
Mrs. J. Slagg, Weaste-lane, Pendleton.
William Slater, Esq., and Mrs. Slater, Halliwell-lane, Cheetham-hill, Manchester.
The Rev. S. A. Steinthal, Manchester.
Mr. Councillor Thompson, Woodhurn, Wilmslow, Manchester.
Th. R. Trueman, Esq., Eccles.
The Rev. A. E. Welby, B.A., Rector of Holy Trinity, Hulme.
The Rev. C. W. Woodhouse, Canon of Manchester, &c.

Warrington Branch.

John Fairclough, Esq., Mayor of Warrington.
Mr. Alderman Burgess.
Mr. Councillor Crosfield.
Mr. Councillor Keane.
Mr. Councillor Whittle.
Mr. Councillor Milner.
John Rylands, Esq.
Charles Broadhent, Esq.
Ed. Brewtnall, Esq.
Th. Longdon, Esq., Borough Surveyor.

Blackburn Branch.

W. B. Bryan, Esq., and Mrs. Bryan.

Burnley.

John Butterworth, Esq., J. P., Burnley.
Mr. Councillor Keighley.
Mr. Councillor Nutter.
Mr. Alderman Scott.

I. Elementary Schools and Teachers' Classes.—The clergy of the Church of England have met at the invitation of the Bishop of Manchester, and formed a committee to take measures to promote improved teaching of Music in elementary schools, the Rev. Minor Canon Elvy, acting as hon. sec. The Diocesan Board has memorialised the Education Department to make the singing in schools real instruction. The memorial is printed as a Parliamentary paper.

Upwards of a hundred of the clergy, resident in and near Manchester, have signed a memorial to the Committee of Council on Education expressing an opinion "that the national cultivation of Music for the due performance of religious services, and for promoting general education and the culture of the people is deserving of the encouragement of the State, as in Germany, France Belgium, Italy, &c., and that in the first instance it appears desirable that efficient instruction in Music should be given in elementary schools and night classes, for which special teachers having musical ability should be trained, and that such schools should be examined and prizes given according to the system already established in subjects of Science and Art."

The School Board of Manchester have memorialised the Government to make Music one of the subjects to be aided by the Science and Art Department. Dr. Watts moved, the Rev. Canon Toole seconded, and it was resolved, that a memorial, of which the following is a copy, be sent by the Board to the Lords of the Committee of Council on Education:—"That, with a view to the improved teaching of Music in Public Elementary Schools, it is desirable that Music be placed on the list of subjects encouraged by the Science and Art Department, and made specially applicable to pupil and assistant teachers, with a scale of grants similar to that specified for results in drawing, and your memorialists would urge that a great impetus would also be given to the popular study of vocal and instrumental music on scientific principles, were a scheme elaborated, whereby certificates (similar to the 'D' drawing certificate) could be obtained by teachers desirous of earning money by giving instruction in music in both its branches, with provisions for a partial certificate of either vocal or instrumental Music similar to the provisions with regard to freehand and other drawing. That in pursuance of this opinion, your memorialists have already established a class for the study of vocal Music by notes, and have placed it under a competent instructor; but they consider it probable that comparatively little progress will be made until the cost of such classes is made merely nominal, and the interest of elementary teachers generally in this subject is secured by the granting of public money for scientific tuition in Music."

The Bishop of Salford called a meeting of his clergy on 20th March, 1878, when it was resolved "That it is desirable that greater care should be given to the cultivation of Music among the people, and especially in the Public Elementary Schools, both for the purpose of congregational singing and for domestic enjoyment," and "that Canon Beesley and Fathers Burke, Daniel, Butler, and Raymond, be invited to examine what is practicable under existing circumstances, and to make recommendations as to the teaching of Music, and as to the Music to be sung by congregations and schools."

II. Training Teachers, &c.—The School Board of Manchester is promoting the formation of night classes in Manchester for training teachers of Music for Public Elementary Schools. At the Owens College evening musical classes are held for instruction in harmony and musical composition, and a choral class is conducted. Here is the foundation for a Manchester Training School for Teachers.

At the Manchester Free Grammar School a class has recently been formed for the study of the theory of Music, and is already well attended. It is proposed, on the completion of the new buildings, to assign to this subject a larger place in the programme than is at present possible.

III. Singing in Churches and Chapels.—The following clergymen have held with great success evening services on week days in their respective churches in Manchester—The Rev. J. A. Atkinson; the Rev. Dr. Burton; the Rev. G. W. Reynolds; the Rev. A. E. Welby; the Rev. T. Wheeler; the Rev. Canon Woodhouse, &c , and are organising a permanent system.

IV. National Training School for Music.—A competition in Manchester for scholarships to be held by a male and female student will take place as soon as £120 a year for five years have been secured.

The following are stated in the Directory of the National Training School for Music, Kensington-gore, to be promoters of scholarships in Lancashire to be held at this school—

The Countess of Derby.	Principal Greenwood, Manchester.
The Countess of Galloway.	E. S. Heywood, Esq., Manchester.
The Viscount and Viscountess Cardwell, *n.s.*	W. H. Houldsworth, Esq., Manchester.
The Hon. Miss Gerard.	William Rathbone, Esq., M.P., Liverpool.
Sir Thomas and Lady Bazley.	Rev. Clementi Smith, Manchester.
Sir Joseph Whitworth, Bart., Manchester.	
Thomas Aston, Esq., Manchester.	
H. Cheetham, Esq., Manchester	

V. Liverpool has already appointed a committee (A. G. Kurtz, President) and sent five students to the National Training School for Music.

Further information about the scholarships will be afforded by Mr. P. Le Neve Foster, M.A., Secretary of the Society of Arts, John-street, Adelphi, London.

VI. Aid by Donations, Subscriptions, &c.—Funds will be required (1) to establish local prizes in elementary schools in the towns throughout the county, and (2) pay for examinations; (3) to found local schools and classes for training local teachers for elementary schools, which may be estimated at £10 each Scholarship for a course of instruction; (4) for sending talented persons of both sexes to the National Training School; (5) for assisting musical services in churches and chapels, &c. As soon as sufficient support has been promised a meeting of supporters will be called. It has been suggested, that in order to interest great numbers in the Association, especially members of families, as small a sum as five shillings yearly for five years might constitute a member of the Association, but that higher sums might also be taken.

An annual sermon will be preached by the Dean of Manchester in aid of funds for awarding to promising youths among the church choirs in Manchester. scholarships to be held at the National Training School for Music.

The Rev. W. Gaskell, M.A., will give an address at Cross-street Chapel on "Music in the Service of Religion," in aid of the objects of the Association.

Donations and annual subscriptions will be received by the accountant (*pro tem*), Mr. F. Scott, 100, King-street, Manchester.

Examiner:—Mr. Edward Hecht, the Owens College, Manchester.

A public meeting of the promoters of the movement is to be held at the Owens College, on Tuesday, the 26th of November. The Bishop of Manchester will preside. It is hoped that Manchester will start a school of Music on somewhat the same principles as its Art school, and that the example will be followed in other large towns having already Art schools.

HALL-MARKING.

The report has recently been published of the select Committee on Hall-marking appointed last session to inquire into the operation of existing Acts, and also to consider the Watch-cases Hall-marking Bill. The committee met a great number of times during the session, but were not able to agree upon a report before the session concluded. The evidence has accordingly been published by itself, with a request that the committee may be reappointed next session. The evidence is rather voluminous, among the witnesses being Mr. E. J. Watherston, Mr. Walter Prideaux, the clerk of the Goldsmiths' Company, Mr. Garrard, of the firm of that name, Mr. Garnett, of the Inland Revenue-office, Mr. E. J. Poynter, R.A., Mr. T. H. Farrer, of the Board of Trade, and several others.

Mr. Watherston was the first witness. He objected strongly to all duties whatever on plate, and also to the compulsory hall-marking, considering that a voluntary mark would be quite as satisfactory. He complained that works of art were seriously injured by the treatment they received at Goldsmiths'-hall, for the purpose of assaying, and maintained that needless damage was often done in this way. He advocated the introduction of the system of testing articles, which he said was employed in France, by a touch-stone and acid, instead of by cupellation. The system of allowing a drawback on exported goods he thought liable to abuse, and so also was that of the rebate on unfinished articles sent for marking; even the license he thought useless and vexatious. He urged that we were at a disadvantage as compared with other countries, notably America, and said that finer work was now being done in the States than here, owing to the restrictions on the trade in this country. The question of marking watch-cases he went into at some length, and argued in favour of the practice of stamping foreign made cases with English marks.

The next witness was Mr. Garnett, who gave evidence upon the existing law and practice, the amount of the revenue, the manner of its collection, the condition of the various assay offices, &c. He also gave his opinion as to the effect upon the general revenue, of any alterations in the duty. Mr. Garnett handed in some statistics of the duties paid on gold and plate, and of the amounts paid for plate-dealers' licenses.

Mr. Garrard was in favour of letting matters remain as they now are, and saw no advantage in any change. He considered the hall-mark an almost necessary protection both for buyers and sellers. In many respects his evidence contravened that of Mr. Watherston, especially as regards the treatment received by plate and watch-cases in the process of assaying and marking. The suggestion of making hall-marking voluntary he considered impracticable; he thought there was no difficulty in the arrangement about the drawback on exported goods, and proved by reference to his books, that the rebate allowed for duty on unfinished articles was really only sufficient to cover the actual loss incurred by the maker. Most of the trade in his opinion were strongly opposed to change, as had been shown at a large meeting of the trade, recently held at St. James's-hall. He did not believe so much first-class plate was made in America, and thought that the rivalry of electro-plate would prevent any remission of duties from having much practical effect on the trade.

Mr. Thomas, who was the next witness, would preserve the duties as the only means of preserving the hall-mark; he thought the regulations under which foreign plate was imported into this country bore hardly on manufacturers.

Mr. W. Prideaux handed in a summary of Acts and Charters relative to the Goldsmiths' Company, and gave evidence as to the practice of the company. He thought that the framing of a consolidating Act would not be so easy as it appeared. The company had no information of the import of foreign plate. They were ready to put the law into force, but it rested with the Customs to see that imported plate was assayed and marked. As regards foreign watch-cases, the company had no power to refuse to mark them, or even to inquire as to their origin. As a matter of fact they knew foreign from English cases, and a record had been kept of the number of the former stamped. Mr. Prideaux next gave some statistics showing the effect of the introduction of electro-plating upon the trade. Electro-plating was in full swing by 1848; the duty for the ten years previous, 1838 to 1848, was £674,600; in the next ten year period it dropped to £487,600; in the last equal

period, ending with 1878, it was £428,400. The duty on gold, which is not affected by electro-plating, had, during the same period, steadily risen in proportion with the increase of population. He believed the amount of silver used for silver plate was only about 100,000 oz. less than the amount used for plating (1,000,000 oz.). As regards the statement that the French Assay-office used the stone instead of the process of cupellation, this was entirely erroneous. Articles were scraped just as in the English Assay-office. The Goldsmiths' Company took every possible pains to ensure the process being carried out in the best and most scientific way. The company derived no profit from the Assay-office. The number of prosecutions by the company was small, but Mr. Prideaux believed their deterrent effect was very great. He believed that, as the law stood, foreign watch-cases should be hall-marked, but the contrary impression was prevalent throughout the trade.

Mr. Bedford, the representative of the American Waltham Watch Company, next gave evidence. It was the practice of his company to import cases from America and Switzerland into England, to have them stamped here, and then to send them back to be finished. All the works were made in America. Both works and cases were plainly stamped with the company's name, and he would like to see a law made to prevent anyone from marking foreign watches as English watches, and selling them as such in English marked cases. He valued the hall-mark as a guarantee of quality, and many cases were stamped with it for the American market.

Mr. Walter Prideaux, in re-examination, gave some explanation of the arrangements he would propose for enforcing payment of duty on foreign plate through the Customs. He then went on to describe the system adopted at Goldsmiths'-hall. Very finely finished work would be passed without assay, and any work of art of older date than 1800 would be exempt from being broken up if it were below standard. From inquiries he had made, he believed that there was very little forgery of hall-marked wedding rings. Gold which was just under the standard was marked with the standard next below or not, according to the owner's wishes.

Mr. Joseph Pyke followed. He would retain the hall-mark, but abolish the duty. He complained of the exemptions, many articles of considerable weight being exempted as jewellery, while the smallest article of plate must be stamped. As regarded wedding rings, from the price at which they could be bought, he felt sure that the mark must often be forged. He believed the removal of duty would enable silver to compete with electro-plate.

Mr. David Glasgow would make the marking of watches optional. The fact that bad watches were put into hall-marked cases and sold as English watches had a most prejudicial effect upon the reputation of our makers.

Mr. Walter Barnard considered the duty useful as protecting the hall-mark. Its removal might increase the trade in silver, but not sufficiently to enable it to compete with electro-plate, and he did not think the public really objected to it. In the absence of the hall-mark, articles could be manufactured of a lower standard, and it would be impossible to detect this by examination. His objection to a voluntary hall-mark was that it would not involve the same penalty for forgery. In practice he never found any inconvenience in getting articles through the Assay-office.

Mr. Gent gave evidence against the system of marking foreign cases, but believed the trade were practically unanimous in desiring that the hall-mark should be retained for watch-cases. If foreign cases were marked with a special mark it would have to be done in such a way as to show at once that the case was of foreign make, and so that it could not readily be obliterated.

Mr. E. J. Poynter, R.A., gave evidence as to his experience of the risk of having works of art destroyed if they proved to be below standard when sent to Goldsmiths'-hall for stamping.

Mr. J. Walker (of Coventry) complained of the injury to the trade of Coventry from having foreign cases marked in England, and gave a good deal of information as to the practice of the trade, &c.

Mr. Rogers (Liverpool), Mr. Read (Coventry), Mr. Joel (Coventry), and Mr. Buckney (Dent and Co.), all followed very much to the same effect.

The last witness was Mr. T. H. Farrer, of the Board of Trade, who argued forcibly against any system of hall-marking being compulsory. He thought it was clear on the evidence that the trade desired to retain the hall-mark, and for the following reasons; it is a convenience in buying and selling old silver; silver plate being considered as a sort of investment, it is convenient that it should have a certain fixed value, apart from fashion; and lastly, it operates protectively, ignoring the principles of free trade. In his view there was no more reason why the public should be protected in buying silver than in buying other things, in fact, there was no reason, because any person could protect himself by having an assay made. A contract between buyer and seller was quite sufficient security. Hall-marking itself, Mr. Farrer said, was an anomaly. It grew out of the ancient notion that gold and silver were "noble" metals, which should not be alloyed or imitated. This was apparent in all the old statutes. Then the action of the law was imperfect. In practice it did not exist as regards gold, for the kind of articles requiring to be hall-marked are not now made of gold. In the case of electro-plate, though there were wide differences in quality, the law gave people no protection, though there was no logical reason why protection was not as necessary in one case as the other. A further objection to the hall-mark was that it often got to be looked on as a sort of trade mark, evidencing not only quality of material, but also place of origin, &c. Hence the objection to foreign cases being stamped in England. The hall-mark merely guarantees quality of material, and if the foreign article is of such quality there is no reason why it should not be so marked. Any system of hall-marking must of necessity operate as a protection against foreigners, who could not send unfinished goods for marking, might have to work to two standards, their own and the English, and ran the risk of having their goods destroyed if they were not up to standard. As to the system of breaking up such goods, it arose from the notion that there was something morally wrong in making goods of anything but standard silver. When the law was not enforced, as when foreign plate or watches were admitted without marking, the protection operated the other way, and in favour of the foreigner. Compulsory hall-marking interfered with manufacture, because it prevented articles being made of several kinds of metal, as copper and silver, or of lower classes of alloys. Mr. Farrer's chief objection to the duty was that it necessitated the use of the hall-mark, but it also had injurious effects of its own. It acted protectively, and it was largely evaded. The difficulty as to stocks in hand was exaggerated, and might be to a great extent got over by giving proper notice. He did not agree with the view put forward by the dealers as to the opinion of the public; he thought the public relied very little on the hall-mark. He would not admit any analogy between analysis of food and metal assaying. The tradesman was punished for selling an article which was not what it purported to be, and the same would always be the case with the precious metals. A voluntary hall-mark Mr. Farrer would not object to, but it should be established by the trade, not by Government. He would not admit that there was any real hardship in allowing foreign cases to be stamped in England. If the mark was looked on as a proof of the place of origin, the public should be disabused of such a notion.

Mr. Farrer handed in a list of unrepealed enactments relating to the manufacture, &c., of gold and silver goods, with a digest of the same, and also papers showing statistics of imports and exports of plate, &c.

INTERNATIONAL PATENT-LAW CONGRESS.

In accordance with the decree of the French Minister of Agriculture and Commerce, the Congrès de la Propriété Industrièlle, including patents for inventions, models and designs of manufacture, trade marks and titles, was held from the 5th to the 17th of September. A full programme of questions to be debated had been prepared by the committee of organisation, and each question was discussed in the morning by one of three sections, before being submitted to the general meeting in the afternoon.

The inaugural séance took place on the 5th September, under the presidence of **M. Teisserenc de Bort**, Minister of Agriculture and Commerce, one of the hon. presidents of the Congress, who was supported by Herr von Chlumetzky, Austrian Minister of Commerce and Public Works.

In commencing the proceedings, **M. Teisserenc de Bort**, after expressing his satisfaction at the readiness with which the invitation to take part in the Congress had been responded to, and welcoming the delegates of foreign Governments, said that if the present Congress was due to individual initiative it soon attracted the attention of the French Government, which did not hesitate to give it patronage. Questions would be discussed which affected labour, industrial progress, commercial morality, and the security of international relations. With regard to the extent of an inventor's right, was his invention merely the appropriation of a common fund of ideas or knowledge which is free to all, or should it be regarded as an absolute property similar to complete, exclusive and perpetual possessions? As this question had long been discussed without any solution being arrived at, it sufficed to inquire whether it was advantageous to the community to grant a monopoly, limited in its duration, to the author or importer of an invention. Most countries had practically answered this in the affirmative by protecting invention; and it must be owned that the absence of protection discouraged experiments on the part of the inventor, who feared imitators; it encouraged secret working, to the great detriment of general progress; and it also had the effect of inducing the inventor to desert his own country for one more favourable to the development of his creations. These considerations appeared to have decided the question; but after recognising the advisability of protecting the right to invention there were two great interests to be reconciled. On the one hand, the inventor must be ensured the enjoyment of the ownership which he had created; and, on the other, society should not be deprived, after a certain length of time, of the free use of a discovery which was an element of progress, so that the march of invention might not be seriously hindered. Three different modes had been sought of reconciling these two interests. In some countries the application was submitted to a preliminary examination, and was only granted on the utility of the invention being established; elsewhere the patent was granted at the risk of the inventor, without guarantee either of the merit of the invention or its accuracy of description; and, according to another system, the patent was only granted after previous publication to enable those interested to dispute the novelty. This diversity of procedure proved that the principles of a sound legislation as to patents had yet to be determined; and this also applied to industrial designs and trade marks. This diversity was also a source of great difficulty and expense to inventors; indeed, uniformity had become a pressing necessity. This had been recognised since 1873, when the Congress at Vienna during the Exhibition was the first step in this direction. M. Teisserenc de Bort concluded his address with the assurance that his department of the Government would attentively follow the deliberations of the Congress, which would be a great assistance in the discussion of the proposition of M. Bozérian, which he hoped would bring about a great improvement in the French law on this question.

M. Bozerian, senator, and one of the vice-presidents of the committee of organisation, traced the career of the late M. Renouard, president of the committee of organisation, but whose decease unfortunately occurred at the moment he was preparing to direct their labours.

MM. Barrault, Lyon-Caen, Bozérian, and De Maillard de Marafy then formally put in the reports of their respective sections, viz., patents (two reports), designs, and trade marks. The final bureau of the Congress was then constituted as follows:—Hon. Presidents, M. Teisserenc de Bort, minister of agriculture and commerce; Herr von Chlumetzky, Austrian minister of commerce and public works; and Dr. C. W. Siemens, President of the Patent Congress at Vienna in 1873. President, M. Bozérian, senator. Vice-presidents, M. Tranchant, councillor of State; M. Dumoustier de Frédilly, director of internal commerce at the French ministry of agriculture and commerce; M. Meurand, director of consulates; M. Barbedienne, manufacturer of bronzes; M. Bodenheimer, deputy to the Swiss Federal Council; Herr Hegedüs, member of the Hungarian Parliament; Herr Klostermann, privy councillor at Berlin; Herr Mullendorff, grand ducal councillor, Luxemburg; M. de Nebolsine, Russian councillor of State; Mr. Pollok, civil engineer, Washington; Herr Reuleaux, privy councillor at Berlin; Herr von Rosas, councillor of finance, Austria; Admiral Selwyn, England; Herr Stoltz, civil engineer, Norway; and Signor Torrigiani, member of the Italian Parliament. General Secretary, M. Ch. Thirion, engineer, Paris. Secretaries, M. Clunet, advocate at the Paris Court of Appeal; M. Albert Grodet, secrétaire du comité du contentieux de l'Exposition; M. Ambroise Rendu, doctor of law, advocate at the Court of Appeal; Mr. Alexander, barrister, London; M. Biebuyck, advocate, Brussels; M. Kaupe, engineer, St. Petersburg; Herr Carl Pieper, civil engineer, Dresden; and Dr. Schmidt, of Vienna.

General Questions.

On the following day, under the presidency of **M. Bozerian**, the discussion turned upon the general consideration of the nature of the inventor's right, which formed the subject of Question No. 1, "The right of inventors to their works, or of manufacturers to their trade marks, is a right of ownership founded on the natural law; the civil law does not create it, but only subjects it to regulation."

M. Dupray de la Maherie contended that this ownership was one of common right, as regarded from the triple point of view of history, philosophy, and experience.

Admiral Selwyn saw no difference between the painter and the inventor as regards the right of ownership in their several productions. It was not true that a man was not an inventor if he had not perfected his invention. The Americans, an eminently practical people, had appointed a preliminary examination of patents, which had given beneficial results; for instance, while England registered 3,000* patents in the year, America had registered 15,000. If the inventor has a right of ownership recognised by every nation, the public had also rights not less important, which should serve as a starting point for fixing those which it might be found advisable to grant inventors.

* The number of English applications was over 5,000 in 1876, and a little below that number last year.—Ed.

Mr. Droz considered that it was of less consequence to seek whence the right proceeded than to know what it was in actual legislation. It was an ownership of special nature, but at the same time one of common right.

M. Limousin considered inventions the result of labour, and, therefore, based upon the principle of ownership as defined by political economy.

Mr. Lloyd Wise felt some difficulty in accepting the proposition, although he agreed in wishing to give all possible protection to authors, inventors, and others. An inventor had the right to his invention only so long as he kept it to himself; but the object of protection was to allow the inventor to "bring his invention out;" and it was very desirable that this should be done as quickly as possible. Sometimes nearly the same idea occurred to more than one individual at about the same time; and sometimes men made inventions and kept them secret. He who first took active steps with a view to introducing his invention was the one who conferred benefit on the public, and who ought (in the absence of fraud) to be rewarded. Assuming the proposition before the meeting to be adopted, it would, on that theory, be impossible ever to decide whether a patentee was the rightful holder of the right to an invention, as a prior inventor might at any time appear and lay claim to it. In his opinion it could not be said an inventor had any exclusive right to his invention (once disclosed) except such as the law expressly gave, and the contrary proposition under discussion would, in his belief, be regarded, at least in England, as altogether unpractical.

M. Lyon-Caen thought that the Congress would do well, at the commencement of its labours, to affirm purely and simply the right of the inventor to the law's protection, without entering into any theoretical discussion of his right.

M. Pouillet, however, argued against this amendment; he thought that as the theoretical question of the right had been posed by the Congress, it should also be settled.

M. Demeur, of Brussels, took the opposite side. The Congress considered it well to pronounce an opinion on the question of principle; and he opposed the counter proposition of M. Schreyer, of Geneva, couched in these terms:—"The right of inventors is a useful and equitable provision of civil law which has reconciled the rights of the inventor and the public by the granting of a temporary monopoly," and supported Question 1, as given above, with the omission, however, of these words "founded on natural law."

After further discussion, the original proposition, with this amendment, was carried.

Proposition No. 2, "Foreigners should be assimilated to natives," was proposed by **M. Clunet.**

M. Imer-Schneider, delegate of the Swiss Confederation, read a declaration made by his Government, to the effect that reciprocity should be required in this matter, a view which was supported by **M. Lyon-Caen.**

After further discussion, the proposition was adopted by the Congress.

On Saturday, 7th, the discussion of general questions was continued.

M. Albert Grodet proposed the following resolution:—"Stipulations of reciprocal guarantee as to industrial ownership should form the subject of special conventions independent of treaties of commerce, and also of conventions as to literary and artistic ownership."

This was supported by **M. Lyon-Caen**, who added, however, that these special treaties should not be of indefinite duration; and the proposition was subsequently adopted.

M. A. Grodet also brought forward and enlarged upon the following:—"A special department of 'industrial ownership' should be established in every country, to which should be attached a central depôt of trade marks and manufacturing designs for reference by the public. Independently of any other publication, a periodical official journal should be published for their service."

Admiral Selwyn, recalling the example of the United States, observed that to require the deposit of models would unnecessarily encumber the central office, and that photographs would be quite sufficient.

M. Maillard de Marafy explained that the proposition intended that only documents should be kept. The French central administration was now unable to carry out the law on account of the depôts being so scattered. A central depôt was absolutely necessary for properly conducting the business of the departments.

Mr. Lloyd Wise supported the proposition of M. Grodet. Before the American Patent-office commenced publishing the *Official Gazette*, he had proposed to Mr. Woodcroft, of the English Patent-office, that reports of Patent-law cases should be given in the Commissioners of Patents journal. The United States *Official Gazette* was a publication such as he would wish to see in England and other countries, where the protection of inventions and designs exists. He also argued that there should be a central office in each country for all patent business. To a certain extent the English Patent-office might be said to be a central office. Some time ago, the business of the registration of designs, which had previously been transacted at a separate office, was transferred to the Patent-office, and the registration of trade marks was also connected with it. The Society of Arts, which, as he need scarcely say, was an influential society, numbering about 4,000 members, had taken great interest in the reform of the law relating to patents and trade marks, and at a meeting held last year to consider the Patent Bill introduced by the Attorney-General, had passed a resolution to the effect that the requirements of the Patent-office should be properly provided for, and a suitable museum and public library maintained, before the funds, derivable from stamp fees, were used for the general purposes of the State. He would not advocate the compulsory deposit of models, which was very hard on the inventor; though some models of important inventions might be constructed at the cost of the State, and preserved as a record of progress.

The resolution was adopted; and the Congress then considered the next proposition. "It is advisable to grant a provisional protection to patentable inventions, to industrial designs and models, as well as trade marks entered at international exhibitions."

M. Ambroise Rendu insisted on the necessity for the provisional protection of inventions represented at international exhibitions, and reminded the Congress that England and Austria had already laws to this effect. A discussion then took place as to what constituted an "official" international exhibition.

Mr. Pollok, delegate of the United States, observed that the international exhibitions of London and Philadelphia were not official, but yet from their importance were fully entitled to protection for their exhibits, an opinion in which Mr. Lloyd Wise concurred.

MM. Pouillet and Barrault demanded the retention of the word "official," that is to say, having the support of the Government. The Congress, however, ultimately adopted the following reading, "official, or officially authorised."

With regard to the proposition, "The length of time during which inventions, trade marks, and designs are protected at international exhibitions should be deducted from the total duration of the ordinary legal

protection, and not added to it," **Mr. Lloyd Wise** objected to deducting from the term of a patent the period of protection accorded in respect of an exhibition. He contended that an exhibition had the object of showing the newest inventions; if the inventor takes so much trouble, he should not be deprived of the protection which he would otherwise have applied for more at his leisure. This had not been the practice in England, nor was it so at the present Paris Exhibition; why, then, should it be introduced now? The provisional protection against the consequences of exhibiting was very different from the exclusive rights granted by a patent. The proposed resolution would have the effect of keeping many valuable inventions out of an exhibition.

This proposition was, nevertheless, affirmed, as also was the next, "The provisional protection accorded to inventors who take part in the above-named international exhibitions should be extended to all countries represented thereat."

The following propositions were also adopted:—"The fact of an article being shown at an international exhibition should not form an obstacle to its being seized if proved an infringement." "Each of the branches of industrial ownership (*propriété industrielle*) should form the subject of a special and complete law." "It is desirable that as regards industrial ownership the same legislation should be in force in a State, its colonies, and the various parts of the same State. It is also desirable that the conventions of reciprocal guarantee of 'industrial ownership,' concluded between two countries, be applicable to their respective colonies.

Patents for Inventions.

On 9th September, the Congress proceeded to the discussion of the following proposition:—"All inventions, all processes, or products, are patentable except combinations or plans of finance and credit, or inventions contrary to public order and morality."

A discussion ensued as to the patentability of chemical products. The speakers included **M. Poirrier, M. Schreyer, M. Lyon-Caen, Mr. Pollok,** and **M. Pouillet.**

The Congress decided that patents should be granted "for chemical and alimentary products;" and the discussion was continued on the patentability of pharmaceutical products by **M. Turguetil, M. Lecoq, M. Genevoix,** and **M. Barrault.**

It was then decided by 46 votes against 38 that patents should be granted to inventors of "pharmaceutical products;" and the Congress passed on to the discussion of the question as to whether patents should be granted "after or without previous examination."

M. Barrault pointed out the importance of this question. In the United States a preliminary examination had been in force for eighty years. In 1877, 23,000 patents were applied for, and 17,000 granted. A preliminary examination had become impossible; and patents had been granted for inventions patented thirty years before. Besides, notwithstanding the enormous expenses of the Patent-office, the examination was deprived of all degree of certainty. In France the preliminary examination had not been adopted; at the end of a year half the patents were no longer in force. Consequently, without any possible error of the administration, the public gained 50 per cent. of the patents. In England, at the end of the seventh year, no more than 7 per cent. of the patents remained in force. The preliminary examination was not, therefore, necessary, since a better result was arrived at without any difficulty.

Herr Klostermann, of Berlin, proposed the following amendment:—"Petitions for patents should be subjected to a preliminary examination, which cannot involve the rejection of the petition by the examiners; but the right of opposition should be granted to the Government as well as to the public, by means of sufficient publicity. Objections formulated in the terms fixed by the law shall be determined by the courts."

Herr Carl Pieper, of Dresden, considered the principle of preliminary examination excellent; and the countries adopting it would have better inventors than those under other regulations. He added that the French members of the Congress attached too much importance to a law made for France.

M. Pouillet opposed the preliminary examination on the ground that examiners could not be obtained. The experience of the United States was not in favour of this system, which had led to abuses; and the German law was of too recent a date to allow of conclusions being drawn from its working. It was not the case that, when there is a previous examination, the patent attracts capital. The United States patent was granted at the risk of the inventors; and those interested could oppose it. The only practical result of the preliminary examination was to weed out useless patents; but experience proved that this took place of itself in countries where there is no previous examination.

M. Leboyer contended that the preliminary examination was a natural consequence of the vote by which the Congress declared that the patent was a "right of ownership" (*droit de propriété*), and was of opinion that if there were no preliminary examinations it was better not to grant patents at all.

M. Charles Lyon-Caen said that the petitions for a patent should be published in such a manner as to inform all interested in the matter. Within a space of time to be fixed opposition might be made to granting the petition. If there were no opposition the patent would be granted; but, if there were opposition, a lawsuit would ensue between the petitioner and the opposer. The judge would refuse or grant the patent, and his decision would be final.

M. Leon Lyon-Caen opposed the preliminary examination. In France, those interested had the power of attacking patents already granted, but this power was hardly ever exercised, and it would be the same for the *procédure provocataire* if adopted. Opposition would often be made merely by way of advertisement. Lastly, the courts would not be competent to appreciate inventions not yet worked.

Mr. Alexander, of London, would not admit the system of *procédure provocataire* proposed by M. Lyon-Caen, but, with this exception, he pronounced in favour of the preliminary examination. In connexion with this subject, he referred to the decisions of the Association for the Reform and Codification of the Law of Nations. In his opinion, a preliminary examination was necessary, in the interests of inventors. He added that, if examiners were sometimes bought, this should not be laid to the charge of the preliminary examination.

On the following day the discussion was continued. **Herr Schmidt,** of Vienna, remarked that preliminary examinations existed in the United States and throughout Europe, except in France, Belgium, and Italy.

The Count de Douhet, senator, desired that when an inventor deposited his petition it should be examined by a competent committee, who should give the patentee an opinion on his invention; and the inventor could make what use he pleased of this opinion.

MM. Bodenheimer and **Imer,** delegates of Switzerland, made the following proposition:—"Patents shall only be registered after publication. In case of opposition they shall be subjected to a preliminary examination bearing upon the degree of novelty of the invention. This examination shall be made by a body, the decisions of which shall be subject to appeal before a superior court."

M. Barrault again pointed out the difficulties of the preliminary examination, the impossibility of seeking

for priority in the 500,000 patents existing in the various countries of the world.

Herr von Rosas, speaking in the name of the Society of Engineers, and of the Industrial Society of Vienna, supported the proposition of M. Bodenheimer. He demanded of the Congress to vote a resolution which should serve as basis for an international understanding.

The proposition was, however, rejected.

MM. Reuleaux (of Berlin), **Poirrier**, and several members, proposed the following ;—"Petitions for patents should be subjected to a preliminary examination, which cannot lead to the rejection of the petition by the examiners; but the right of opposition should be granted both to the Government and to the public by means of suitable publicity. Opposition made in the terms fixed by the law shall be judged by the Courts." (Rejected.)

MM. Lloyd Wise, Reuleaux, Thirion (general secretary), and **Perisse**, proposed the following resolution:—"A patent should be granted to every applicant at his own risk and peril. It is, however, advisable that the petitioner should receive a preliminary opinion on the question of novelty, so that he may, at his discretion, maintain, modify, or abandon his claim.

M. Droz remarked that there were seven or eight special methods of preliminary examination before the meeting, and that there was, consequently, but one way of arriving at a conclusion, viz., to reject the preliminary examination altogether. Referring to the proposition, he thought that the opinion given by the Government would be a cause of difference between it and the courts.

M. Schreyer (Swiss delegate) called upon the Congress to vote the resolution relative to the opinion to be given to inventors, and spoke very strongly in favour of the resolution proposed by Mr. Lloyd Wise and others.

M. Couhin called the attention of the Congress to the true character of the resolution, and explained how it constituted a compromise between the system of preliminary examination and that of non-examination.

M. Pouillet was in favour of the proposition, at the same time observing that the question of non-examination remained intact.

MM. Grodet, Meissonier, and **Barbedienne** demanded that this opinion be only given if interested parties claimed it; but this addition was rejected.

The resolution was finally adopted as follows:—"A patent should be granted to every applicant, at his own risk and peril. It is, however, advisable that the applicant receive a previous and secret opinion, especially on the question of novelty, to enable him, at his discretion, to maintain, modify, or abandon his claim."

The Congress also adopted the following resolution, "Patents should be subject to a fee, and also that this fee should be periodical and annual."

On Question 5, "The tax should be progressive, starting from a moderate sum" (which was adopted), **Mr. Alexander** had presented the following amendment, which was rejected, "The fees should not exceed the sum necessary to cover the expenses of the Patent-office."

The following resolution, proposed by **M. Pataille**, was adopted, "The fees should only be demanded in the course of the year."

On Wednesday, 11th September, **M. Bozerian** presiding, the Congress was engaged with measures for an international understanding for the protection of inventions and trade marks.

Signor Romanelli, the delegate of Italy, brought forward a proposition as to the nomination of a permanent commission, charged with ensuring the carrying out of the resolutions passed by the Congress, and the following proposition was carried:—"A permanent commission shall be nominated, charged with ensuring, as far as possible, the realisation of the resolutions passed by the Congress."

Herr Carl Pieper, Secretary-General of the Vienna Patent Congress, said that the last resolution passed by that Congress had the object of pressing for the realisation of all the resolutions that had been voted, and he begged the Paris executive committee to pursue the same objects.

After further discussion, the following was adopted:—"One of the objects of this commission, appointed through private initiative, will be to bring about, at the summons of one of the Governments, the meeting of an official international conference, for the purpose of determining the bases of a uniform legislation."

On the proposition of **Admiral Selwyn**, it was resolved that a deputation should wait upon the French Minister of Commerce and Agriculture, begging him to take measures for the meeting of an international commission for ensuring a uniform Patent-law.

The following proposition of **M. Colfavru**, of Cairo, was then adopted:—"The Congress express a desire that, with regard to Eastern countries which have not provided with laws for the protection of inventions, and especially Egypt, where there is a mixed international jurisdiction, diplomacy should intervene to secure from the Governments of these countries effectual measures for ensuring to inventors and manufacturers a respect for their property."

A discussion then took place on the following proposition, and it was adopted:—"It is desirable that the deposit of petitions for patents, trade marks, and designs take place simultaneously with a competent local authority, and at the consulates of the various foreign nations."

The Congress next proceeded to discuss at length the right belonging to the inventor; it rejected a resolution as to an obligatory license for the whole duration of a patent, and another as to one for half the time, and ultimately passed the following:—"Patents should ensure, during their whole duration, to inventors or their assigns, the exclusive right of working the invention, and not merely the right to a royalty to be paid by other parties working it."

Manufacturing Designs and Models.

On Thursday, 12th, the discussion of resolutions as to manufacturing designs and models was down on the paper, and the following resolutions were adopted:—"A definition of manufacturing designs and models should be given by the law which regulates them." "Every arrangement of lines or colours intended for an industrial production, and all the effects obtained by combinations of weaving or impression, shall be regarded as industrial designs; all works in relief intended to constitute, or form part of an industrial object, shall be regarded as industrial models; no design having an artistic character, or object due to the art of the sculptor, shall be included in these categories, although they may be intended for an industrial reproduction; as to inventions in which the form is only sought by the inventor with respect to the industrial result obtained, they shall be governed by the special law as to patents." "The duration of the right of ownership guaranteed by Art. 1, shall be of 2, 3, 4, 5, 10, 15, or 30 years, at the will of the applicant. If this right shall have been claimed for less than thirty years, it may be prolonged until the expiration of this period, on payment of the fees."

Patents.—(*Continued.*)

The resolution, "The introduction into the country of patented objects manufactured abroad should not be forbidden by the law," was opposed by **M. Pataille** in the interest of national industry, but supported by **M. Droz** in consequence of the previous vote, which assimilated foreigners to natives, and adopted.

The following were also adopted:—"Forfeiture in default of paying the fees can only be pronounced after the expiration of a certain period following the date of forfeiture. Even after the expiration of this period, the patentee should be allowed a hearing to enable him to justify the causes which have prevented him from paying." "It is advisable to admit the principle of forfeiture in default of working within a certain period to be determined, unless the patentee justify his inaction." "This forfeiture shall be pronounced by the ordinary courts, and not by the Government."

Manufacturing Designs and Models.

On Wednesday, 13th September, the business before the Congress was the examination of the conditions under which the protection of the law should be granted to the inventors of manufacturing designs and models, when the following points were decided:—"The protection granted by the law to the inventors of designs and models should be subjected to the condition of a previous deposit." "The deposit should remain secret for two years." "The certificate of deposit shall be granted at the risk of the depositor." "At the expiration of the period determined for the open deposit, the designs and models shall be placed at the disposal of the public, but shall not be published officially." "Nevertheless the official journal of the service of the *propriété industrielle* of each country should publish periodically the names of the depositors, with an indication of the objects deposited." "It is desirable that, in every country, the striking out by the competent authority of fraudulent registrations, and also the substitution of the name of the rightful owner, be prescribed by law." "The weight of the deposit should not exceed 10 kilogrammes." "Registrations of industrial designs or models should be subject to the payment of a fee." "It is not advisable to subject the authors of designs and models to forfeiture on account of non-working." "In order to benefit by the legal protection, the authors of registered designs and models should, as far as possible, mark them with a special sign, showing that they are registered, as well as the date and duration of the deposit." "The infringement of a patented invention, a trade mark, or an industrial design or model, that has been registered, is an offence against the common law."

Trade Marks.

On the 14th September, under the presidency of **Herr Reuleaux**, director of the Gewerbe Akademie of Berlin, the principle of ownership in trade marks was considered, and the following amongst other resolutions were adopted:—

"A trade mark cannot be claimed before the courts, unless it has been properly registered."

"Every mark registered in a country ought also to be admitted, just as it is on the register, in the countries in union."

Dr. C. W. Siemens, in thanking the Congress for electing him one of the honorary presidents, regarded this honour as a compliment paid to the Vienna Congress, whose wishes he now hoped to see realised; and the meeting was adjourned to the 16th.

September 16 and 17.

At the meetings on these two days a number of resolutions, for the most part of minor importance, were adopted in relation to industrial rewards, the fraudulent use of medals conferred at exhibitions, &c., also in relation to trade marks and patents, and the Congress appointed a permanent commission to carry out its views. The members of the English section of this permanent commission are Admiral Selwyn, Mr. J. G. Alexander, Mr. Lewis Olrick, and Mr. Lloyd Wise; and there remain three vacancies to be filled up.

NOTICES.

THE LIBRARY.

The following works have been presented to the Library:—

A Memoir of the Indian Surveys, by Clements R. Markham, C.B., F.R.S. (London: W. H. Allen and Co., 1878.) Presented by the Secretary of State for India.

The World on Wheels; or, Carriages, with their Historical Associations, from the earliest to the present time, by Ezra M. Stratton. (New York: Published by the Author, 1878.) Presented by the Author.

Sixth Report of the Commissioners of the Exhibition of 1851. (London: 1878.) Presented by the Commissioners.

The History and Principles of Weaving, by Hand and by Power, by Alfred Barlow. (London: Sampson Low and Co., 1878.)

Description Économique et Commercial des Forêts de l'état de Hongrie. Par ordre de M. Koloman Széll, Ministre des Finances. Redigé par Albert Bedö, Conseiller en Chef des Forêts de L'etat. (Budapest, 1878.) Presented by John Fretwell, jun.

The following pamphlets have also been presented by their author:—

Hints on Church Music, by J. T. Whateley.

Hints on Singing and the Cultivation of the Voice, by J. T. Whateley.

MEETINGS FOR THE ENSUING WEEK.

Mon.... Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Opening Address by the President, Mr. William Sturge.

Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. 1. Sir Rutherford Alcock, Opening Address. 2. Mr. L. M. D'Albertis, "Journey up the Fly River, and in Other Parts of New Guinea."

Tues.... Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Mr. J. B. Mackenzie, "Avonmouth Dock." 2. Mr. T. R. Salmond, "The River Lagan and Harbour of Belfast." 3. Mr. J. E. Williams, "Whitehaven Harbour and Dock Works."

Anthropological Inst., 4, St. Martin's-place, W.C., 8 p.m. 1. Mr. R. Cust, "Report on Anthropological Proceedings at the Oriental Congress." 2. Mr. J. Park Harrison, "Some Characters Tatooed on a Motu Woman." 3. Prof. Daniel Wilson, "Some American Illustrations of the Evolution of New Varieties of Men."

Thurs... Meteorological, 25, Great George-street, S.W., 7 p.m. Mr. Richard Strachan, "The Barometer and its Uses: Wind and Storms."

Mathematical, 22, Albemarle-street, W., 8 p.m. Anniversary. 1. Lord Rayleigh, "Instability of Jets." 2. Prof. M. W. Crofton, "Self-sustained Frames of Six Joints."

Fri....... Philological, University College, W.C., 8 p.m.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,356. VOL. XXVI.

FRIDAY, NOVEMBER 15, 1878.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

ARRANGEMENTS FOR THE SESSION.

The First Meeting of the One-Hundred-and-Twenty-fifth Session of the Society will be held on Wednesday next, the 20th inst, when the Opening Address will be delivered by Lord ALFRED S. CHURCHILL, Chairman of the Council. Previous to Christmas there will be Four Ordinary Meetings, in addition to the Opening Meeting, and the Papers will be read by Captain Burton, Mr. J. N. Shoolbred, Mr. Hyde Clarke, and Dr. Gladstone. The subjects and dates of these papers are given below.

Candidates proposed for election as members are privileged to attend on this occasion.

Evening Meetings of the Society will be held on the following dates, subject to any alterations which may be found necessary:—

ANNUAL GENERAL MEETING.

The Annual General Meeting will be held on June 26th, at four o'clock.

ORDINARY MEETINGS.

The following arrangements for the Wednesday evenings before Christmas have been made:—

NOVEMBER 20.—Opening Meeting. Address by Lord ALFRED S. CHURCHILL, Chairman of the Council.

NOVEMBER 27.—"The Land of Midian," by Captain RICHARD FRANCIS BURTON.

DECEMBER 4.—"Electric Lighting," by Mr. JAMES N. SHOOLBRED.

DECEMBER 11.—"Railways to Turkey and India." By Mr. HYDE CLARKE.

DECEMBER 18.—"Science Teaching in Elementary Schools." by Dr. J. H. GLADSTONE, F.R.S.

At the meetings after Christmas the following papers, amongst others, will be read:—

"The Distribution of Disease popularly considered." By Dr. ALFRED HAVILAND.

"The Social Necessity for Popular and Practical Teaching of Sanitary Science." By Mr. JOSEPH J. POPE, M.R.C.S., L.S.A.

"The Best Methods for Improving the Condition of the Blind." By Dr. T. R. ARMITAGE.

"Indian Pottery at the Paris Exhibition." By Dr. G. BIRDWOOD, C.S.I.

INDIAN SECTION.

The meetings of this Section will take place on the following Friday Evenings, at Eight o'clock:—

January 31, February 21, March 7, April 4, May 2 and 23

	CANTOR LECTURES.	ADDITIONAL LECTURES.	AFRICAN MEETINGS.	ORDINARY MEETINGS.	CHEMICAL MEETINGS.	INDIAN MEETINGS.
	Monday.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
1878.						
NOVEMBER	— — — 25	— — — —	— — — —	— — 20 27 —	— — — —	— — — —
DECEMBER........	2 9 16 —	— — — —	— — — —	4 11 18 — —	— — — —	— — — —
1879.						
JANUARY	— — 20 27	— — — —	— — 21 —	— 15 22 29 —	— — 16 —	— — — 31
FEBRUARY........	— 17 24 —	3 10 — —	4 — — —	5 12 19 26 —	— 13 — —	— — 21 —
MARCH	3 10 17 24	— — — —	— 18 — —	5 12 19 26 —	— 13 — 27	— 7 — —
APRIL	— — 21 28	— — — —	1 — — 29	2 — — 23 30	— — — 24	4 — — —
MAY	5 12 19 —	— — — —	— — 27 —	7 14 21 28 —	— 15 — —	2 — 23 —

Juvenile Lectures, Friday, January 3rd and 10th.

THE CHAIR WILL BE TAKEN AT EIGHT O'CLOCK AT EACH OF THE ABOVE MEETINGS.

AFRICAN SECTION.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock:—

January 21, February 4, March 18, April 1 and 29, May 27.

CHEMICAL SECTION.

The meetings of this Section will take place on the following Thursday Evenings at Eight o'clock:—

January 16, February 13, March 13 and 27, April 24, May 15.

CANTOR LECTURES.

The First Course of Cantor Lectures will be by Mr. W. MATTIEU WILLIAMS, on "Mathematical Instruments." It will consist of

Six Lectures, to be given on the following dates:—

November 25, December 2, 9, 16, January 20, 27.

The Second Course will be by Dr. W. H. Corfield, M.A., on "Household Sanitary Arrangements." It will consist of Six Lectures, to be given on the following dates:—

February 17, 24, March 3, 10, 17, 24.

The Third Course will be by Mr. W. H. Preece, on "Recent Advances in Telegraphy." It will consist of Five Lectures, to be given on the following dates:—

April 21, 28, May 5, 12, 19.

Additional Lectures.

A course of two lectures will be given by Dr. B. W. Richardson, M.A., LL.D., F.R.S., on "Some Further Researches in Putrefactive Changes," in continuation and completion of his course of Cantor Lectures given last session. The dates for these lectures will be the 3rd and 10th February.

Juvenile Lectures.

The usual short course of lectures adapted for a juvenile audience will be given by Mr. W. R. S. Ralston, M.A., on "The Mythology of Fairy Tales." The dates for the lectures will be the 3rd and 10th January next. The lectures will commence at seven o'clock. Special tickets will be issued for these lectures.

Health and Sewage of Towns Conference.

The annual Conference will be held in the month of May, on a date to be announced hereafter. The subjects for the coming Congress will include Water Supply.

Domestic Economy Congress.

It is proposed to hold the annual Congress this year at Leeds. The date and other arrangements will be announced later on.

Admission to Meetings.

Members have the right of attending all the Society's meetings and lectures. They require no tickets (except for the Juvenile Lectures), but are admitted on signing their names. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor Lectures. Books of tickets for the purpose have been issued to the Members, but admission can also be obtained on the personal introduction of a Member.

INSTITUTIONS.

The following Institution has been received into Union since the last announcement:—

Cambridge-house School, The Grove, Blackheath, S.E.

THE JOURNAL.

Arrangements have been made for the transmission of the *Journal* in future entirely by post. Up to the present it has been sent to members residing in London by hand; but it has been found that, with the large and increasing numbers of the Society's members, this hand delivery now occupies too long a time, and causes delay in the delivery of the *Journal* to many members. It is thought that a more certain and regular delivery is likely to be secured by the ordinary postal arrangements. All the copies of the *Journal* will, therefore, in future, be posted before the evening post of the Friday in each week, and members should receive them at least by the first morning post on Saturday. It is specially requested that any irregularity in the receipt of the *Journal* may be at once notified to the Secretary.

NATIONAL WATER SUPPLY.

The "Notes on Previous Enquiries," prepared by direction of the Committee on this subject, are now ready, and can be had, price 1s. 6d., at the Society's House, or from Mr. G. Bell, the Society's publisher. The pamphlet contains a list, as complete as can be made, of all Reports of Commissions, Committees, Standing Boards, &c., and of all Official Publications dealing with the question of water supply. It also gives extracts from such books as are known to be out of print, but contain matter likely to be generally useful.

The Secretary will be glad to receive notice of any additions or corrections, which shall appear either in the Society's *Journal*, or in a future Supplement, as may seem desirable.

CORRESPONDENCE.

MINERAL RESOURCES AT CONSTANTINOPLE.

Consul Wrench (p. 947) cannot be said to have given a fair view of mining legislation in Turkey, when he accuses the Government of manifesting hostility to mining enterprise. It will be very useful if Mr. Wrench and other English officials will bestow their attention on this and other questions of progress.

So far from the Ottoman Government having manifested hostility to mining enterprise, they have for years made constant efforts to promote it, and have been greatly disappointed at their want of success. For years they have maintained a mining department of natives and foreigners at great expense.

The cause of their failure is this, that, as they generally do, they applied for advice to the centre of civilisation at Paris, and in this case to the worst quarter they could, as they would have done better with Germany, Spain, or Russia, than with France, which does not take the first rank as a mining country. The French supplied them with such a code of supervisions and regulations as was sufficient to hamper enterprise, and, besides, suggested a very heavy tariff of royalties.

The Government did not find this out for many years, as they were well disposed to believe that mining is a most gainful branch of industry, and that they had adopted the best course to promote it. In this they were encouraged by foreign and Levantine adventurers, who applied to them for monopolies and concessions of mines on a large scale, for the purpose of selling them in the West. Such schemes are still going on.

Many years ago Ismael Pasha, being then Minister of Public Works, had charge of the working of the mining regulations, and applied to me. I told him that mining is one of the most speculative industries, that his tariff and regulations were in the wrong direction, and that he had better adopt, as a model, a free mining system like the laws of New Spain, generally applied in South America.

He was impressed by these statements, but was resisted by Dervish Pasha, the Director of Mines, a very able man, who had been brought up in France. So the Government tried a large reduction of the tariff with no result, and afterwards a further reduction. However, as Consul Wrench reports, the administration is still an impediment, while anyone who applies for a mine is liable to be tripped up by some of the native Christians, who put in a counter claim, just as the English have suffered in India, in applying for waste lands.

Numerous financiers are now busy with schemes for paying off the foreign debt of Turkey and increasing her resources by obtaining a concession of all the mines. This, like most of the propositions with regard to Turkey, is a delusion. The working of the mines will be of the greatest benefit to the population of Turkey, and indirectly, but not directly, to the revenue; but, in order to induce persons to apply capital, the mines must be left free, and, above all, kept out of the hands of the English, French, and German jobbers.

Hyde Clarke.

THE PROSPECTS OF INDUSTRIAL INSTRUCTION.

A rather interesting opportunity for comparing educational progress in Australia and the mother country, has lately been offered by a letter I have received from Sydney, New South Wales, demanding advice concerning the rules of management for a technical college about to be established in that prosperous colony. Already a block of buildings has been erected at an expense of several thousands of pounds, and we may hear of the inaugural ceremony before the first stone of anything of the kind is laid in our slow-going metropolis. It is true that a spirit of revival has for some time been manifesting itself among our City guilds. The Clothworkers in particular have really accomplished much practical good at Stroud, and especially at Leeds.

A hopeful sign of success, and one which I refer to with particular pleasure, is the additional impetus given by the liberality of the Clothworkers' Company to the Society of Arts Technological Examinations, instituted in 1873, through the praiseworthy exertions of Colonel Donnelly. A sum of two hundred guineas, offered for premiums to science teachers on the success of their pupils, has already produced very promising results. In 1877, before this incentive was brought to bear, the number of candidates was 68. Of these, 37 obtained technological certificates, and 10 more would have obtained them but that they had failed to pass the required South Kensington examinations in pure science. In the present year (1878) the total number of candidates showed a gratifying increase to 184, of whom 90 obtained the full technological certificate, and 49 would have obtained it if they had passed the pure science examinations. Apparently the South Kensington curriculum, having been originally designed for a different class of students, is rather above the capabilities of ordinary artisans. There is, indeed, a frequent complaint that learned scientists addressing them, either orally or in print, are apt to aim above their heads. This I have attempted to explain as follows, in "Technical Training":—"It is difficult for a *savant*, who, through the toil of many years, has arrived at a familiar acquaintance with the most recondite depths of science, to resume in thought the unfledged mind with which he began his career, to identify himself with the inexperience of his hearers, and to see the difficulties which they see." Yet, in order that our national system of technical training may rest on a broad and sure basis, the whole substratum of the industrial community must be more or less permeated with those fundamental notions of elementary science, without which the artisan cannot be expected to understand the *rationale* of his trade, or to regulate intelligently the disbursement of his wages. The instruction to be thus widely propagated must not only be so obviously of the kind working men want that they themselves will readily acknowledge it to be such; but it must be convenient to diffuse, easy to acquire, attractive, entertaining, and cheap, and the thoroughness of its acquisition must be tested by corresponding examinations, so contrived as to be satisfactory to the examiner, and yet not calculated to frighten the untutored artisan. As every attempt, however humble, to approach these desiderata may be at least suggestively useful, I feel that I need not apologise for publishing, after nine years' trial among the artisans of London, the course of lectures entitled "Science made Easy;" but as several of the devices therein adopted diverge considerably from the ordinary educational routine, I take this opportunity of giving, concerning them, certain explanations which could not appear in the brief prospectus issued by Messrs. Hardwicke and Bogue. I am anxious to show that the new paths which I have opened are not merely for my own use, and that some of them may be pursued with important results by those who, profiting by my pioneering labours, may proceed with ample means, and with the *prestige* of eminence, or the support of authority.

Instead of inviting uninitiated working-class students to devote themselves to one or two isolated branches of science, I recommend them to acquire, as a groundwork for future attainments, and in many respects as an immediate benefit, a selection of the fundamental facts and principles of physics and chemistry, with a few notions concerning the three kingdoms of nature, and a good insight into human physiology. I will not repeat the arguments in favour of this plan, which I have given in "Technical Training," and elsewhere, but will simply show how I was led to its adoption by a logic safer than argument, that of practical experience.

Having by a peculiarly favourable concourse of circumstances been made well acquainted with the wants and resources of industrial life in this and other countries, I became convinced that much good might result from making their nature better known, and their study more attractive. I was thus induced to get together, through the toil and outlay of many years, the classified series of illustrations of dwellings, fittings, and furniture, of clothing, of food, and in short of every department of household and health economy, which constituted the Twickenham Economic Museum. Throughout this vast collection, attractiveness was intended to be the vehicle of practical knowledge. Printed or written labels, supplemented where necessary by the oral explanations of the curator, taught the visitor what he should select and avoid, and this teaching did not merely consist in impressing on his memory empirical instructions, which might be at fault at every new change of circumstances, but conveyed the scientific appreciation of every object, and the *rationale* of every process. The information was couched in the simplest possible terms, but, unfortunately, even these were scarcely understood by working men, into whose education hardly an atom of science had entered. A careful comparison of the

condition of their minds, and of the facts and principles they were required to understand, pointed unmistakably to the branch of science above named. I accordingly felt that I could not be far from the mark in considering them as the proper foundation for that science of daily life which my museum was intended to impart, and I resolved to embody them, under the title of "Science made Easy," in a course of nine or ten lectures, familiar and elementary, but methodical, connected, and progressive. I was not without fear lest so comprehensive a range might prove too much for the powers of endurance of artisans, who, after the toil of the day, are naturally inclined to seek recreation, and I must confess, that the exemplary attention and steadily increasing numerical strength of audiences admitted with open doors to the delivery of the course, in some of the poorest localities in the metropolis, were to me an agreeable surprise. It is clear that the characteristic earnestness of purpose of our artisans can, by appropriate devices, be turned to educational account more easily than has generally been supposed; and I hope that this conclusion may give furtherance to the less sensational and desultory, and more strictly educational class of popular lectures, which appears to be gradually prevailing.

I must refer to the "Introduction" which forms Part I. of my printed course, for an account of the Binary System, by means of which scientific instruction, with a full accompaniment of diagrams and experiments, may be issued from an educational centre, simultaneously in all directions, and delivered in identical words with the fluency of a first-rate professor. As regards the so-called "open-handed" system of examinations, it will be best appreciated by inspecting the programme in which its regulations are published, and which may be had on application to the Twickenham Economic Museum. I may be allowed to add a word concerning the heterogeneous character of the series of diagrams and tablets published with the course for lecture-hall illustration. It occurred to me that the satisfaction to myself of seeing the assortment uniform in style, would be far outweighed by the advantage to the public of comparing the results of eight or ten different styles, plain and coloured, selected according to circumstances from the various modes of block printing, zincography, lithography, and photo-lithography, with which science has enriched the domain of art. A peculiar apparatus adopted by Messrs. Hardwicke and Bogue facilitates the comparison, and is likely to interest dealers in educational prints, whilst their producers will be willingly accorded the benefit of my varied experience, provided they agree to make the commercial interest a secondary consideration in the furtherance of educational progress.

T. TWINING.

Twickenham, Nov. 12th, 1878.

GENERAL NOTES.

Technical Education.—A meeting was held on Monday, at Mercers'-hall, to formally constitute the "City and Guilds of London Institute for the Advancement of Technical Education." The meeting was the first held by the Board of Governors which the provisional committee of the Guilds had recommended should be constituted as the supreme governing body of the new institute. This body consists of representatives from subscribing Livery Companies, nominees from the Court of Common Council, the Lord Mayor and other City officials, with a president and twelve vice-presidents. The first business was the election of the council, who, after their appointment, elected, as their chairman, Lord Selborne; they then proceeded to select the executive committee of the council, which will in future be the real working Board of the institute, and is composed partly of elected members and partly of nominees. Mr. Bramwell, the deputy-chairman of the provisional, became the chairman of the executive committee. This formal business over, the committee took into consideration the report of the provisional committee, and decided to prepare a scheme thereon which might be laid before an early meeting of the council. The amount of available income already promised is over £12,000, but it is anticipated contributions will be given by the companies who have not yet joined in the scheme. The proposals the committee have before them include the establishment in London of a central technical school, the establishment and assistance of evening classes, trade schools, &c., and the development of technical examinations similar to those of the Society of Arts. It was stated that the Commissioners of the 1851 Exhibition were proposing to erect a building at South Kensington in which would be included a technical school, and it was, therefore, understood that either some arrangement would be come to with them, or the execution of the proposals connected with the London school would be deferred till the action of the Commissioners was definitely known.

MEETINGS FOR THE ENSUING WEEK.

MON.... British Architects, 9, Conduit-street, W., 8 p.m. Chairman's Opening Address.

TUES.... Royal Colonial, 8 p.m. (at the HOUSE OF THE SOCIETY OF ARTS), Mr. Frederick Young, "England and her Colonies at the Paris Exhibition."

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Discussion upon papers on "Avonmouth Dock," "The Belfast Harbour," and "The Whitehaven Harbour and Dock Works."

Statistical, Somerset-house-terrace, Strand, W.C., 7¾ p.m. Opening Address by the President, Mr. G. I. Shaw-Lefevre, M.P.

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Prof. Owen, "The Relative Positions to their Construction of the Chambered Shells of Cephalopods." 2. Sir Victor Brooke, Bart., "The Classification of the Cervidæ, with a Synoptical List of the Existing Species." 3. Sir V. Brooke, Bart., "A New Species of Gazelle."

WED. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Opening Meeting of the Session. Address by Lord Alfred Churchill, Chairman of Council.

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Rev. T. A. Preston, "Report on the Phenological Observations for 1878." 2. Rev. Fenwick W. Stow, "Up-Bank Thaws." 3. Capt. Henry Toynbee, "Comparison of Thermometric Observations made on board ship."

Geological, Burlington-house, W., 8. p.m. 1. Prof. P. Martin Duncan, "The Upper-Greensand Coral Fauna of Haldon, Devonshire." 2. Mr. J. W. Davis, "Notes on *Pleurodon affinis*, sp. ined., Agassiz, and description of the Spine of a Cestraciont from the Lower Coal-measures." 3. Mr. C. E. Austin, "The Distribution of Boulders by other agencies than that of Icebergs."

Archæological Association, 32, Sackville-street, W., 8 p.m. 1. Rev. S. M. Minton, "Melbourne and its Locality." 2. Mr. Thomas Blair, "Roman Monument from Brementium with Syriac Inscriptions."

THUR ...Linnean, Burlington-house, W., 8 p.m. 1. Rev. R. Boog Watson, "Preliminary Report on the Mollusca of the *Challenger* Expedition, viz., the genera *Dentalium, Siphodentalium*, and *Cadulus*." 2. Mr. John Miers, "The Symplocaceæ." 3. Mr. R. Irwin Lynch, "Tuberous Branch Terminations in *Vitis Gongylodes*."

Chemical, Burlington-house, W., 8 p.m. 1. Dr. C. M. Tidy, "The Processes and their Comparative Value for determining the quantity of Organic Matter in Potable Waters." 2. Prof. A. H. Church, "A Chemical Study of Vegetable Albinism." 3. Dr. Gladstone and Mr. Tribe, "Researches on the Action of the Copper-zinc Couple on Organic Compounds." 4. Dr. Dupré and Dr. Hake, "A New Gravimetric Method for the estimation of Minute Quantities of Carbon."

Meteorological, 25, Great George-street, Westminster, S.W., 8 p.m. Rev. W. Clement Ley, "Clouds and Weather Signs."

Society of Public Analysts, Burlington-house, Piccadilly, 8 p.m. 1. Mr. C. Heisch, "The Sale of Food and Drugs Act, in its Relation to the Dilution of Spirits." 2. Dr. Dupré, "The Sale of Food and Drugs Act, in its Relation to the Dilution of Spirits." 3. Mr. G. W. Wigner, "The Clauses of the Sale of Food and Drugs Act which relate to the Purchase of Samples." 4. Dr. Dupré, "The Estimation of Alum in Flour." 5. Mr. G. W. Wigner, "The Analysis of Cleopatra's Needle." 6. Mr. G. W. Wigner, "The Nitrogenous Constituents of Cocoa."

FRI.......Quekett Microscopical Club, University College, W.C., 8 p.m.

SAT......Physical, Science Schools, South Kensington, S.W., 3 p.m. Mr. C. Boys, "A Condenser of Variable Capacity."

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Chemist and Druggist.
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Monatsschrift für den Orient.
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Musée de l'Industrie, Bulletin du.
National Education League
National Life Boat Institution, Journal of the.
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Royal Colonial Institute, Proceedings of the.

LONDON: PRINTED BY W. TROUNCE, GOUGH-SQUARE, FLEET-STREET. E.C.